METAL INDUSTRY

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Nickel Futures

A TURN-ABOUT in the supply-demand situation for nickel was brought about in the year just past, says Dr. J. F. Thompson, chairman of The International Nickel Company of Canada, in a year-end review of the nickel industry. After many years of nickel shortage for civilian purposes, the combined supply of market and premium price nickel came into close balance with demand in nearly all areas of the world during the latter part of 1957. This change was brought about by a record free-world production of nickel, sharply reduced defence demands and the United States Government's endeavour to divert to industry, during the year, all nickel scheduled for stockpile intake. While defence requirements were substantially lower than in 1956, civilian consumption increased to the extent of approximately compensating for the reduced defence consumption.

In his review, Dr. Thompson states that free-world nickel supplies last year are estimated at 245,000 short tons, compared with the previous high of approximately 225,000 tons in 1956 and 412,500 tons in 1955. For the eighth consecutive year, International Nickel, last year, operated at capacity and the company's deliveries of nickel in all forms will exceed 145,000 tons. Of the total nickel supplies available in 1957 an estimated 60 per cent was delivered to the United States, with about 40 per cent going to Canada, the United Kingdom and other countries outside the Iron Curtain. Whereas there have been recent years in which 40 per cent of output was consumed by defence and stockpiling requirements, only about 20 per cent was required for these purposes in 1957.

Looking into the future, Dr. Thompson says "Barring any presently unforeseen large increases in defence demands, it is expected that there will be more nickel available to the industries of the free world in 1958 than was the case last year. Consequently, the supply-demand position throughout the world should be in close balance, although some supplies offered during the year will continue at premium prices. In view of the announcement of the U.S. Government that it desires to divert to industry all nickel scheduled for stockpiling it is expected that the supply in the U.S.A. will exceed the demand." Creating larger markets in preparation for the time when the various expansion programmes of the company, and other producers are realized, is a major task confronting all producers in the industry. It is estimated that by 1961 the annual total free-world nickel-producing capacity will approximate between 325,000 and 337,500 tons, with much of the increase government stimulated or sponsored. In particular, Dr. Thompson refers to the atomic field in which the plants for the extraction and refining of uranium and the utilization of atomic energy make continued wider use of nickel and its alloys. The correction which has now occurred in the supply-demand position together with the outlook for much larger quantities of market price nickel a few years hence, should give confidence both to those who wish to restore old nickel uses and to those who will benefit by including nickel in their long-range plans.

Out of the MELTING POT

Introducing YOU know all about powder metallurgy, and you have heard about fibre metallurgy. Now meet foil metallurgy. Differing from the other two so far as the "raw" or starting material is concerned, it shares with them the common principle of the moulding of the starting material to the desired, or some intermediate, shape by the application of pressure, and the consolidation of the product by sintering. The scope and possibilities of foil metallurgy can at this stage be indicated most conveniently by a few patent claims which—since no actual patent application has been filed—anybody skilled in the art is welcome to try and carry further in theory and practice. The main points of foil metallurgy may be claimed to be: 1. Process for making metal parts by randomly or otherwise crumpling one or more longitudinally continuous or discontinuous strips of foil, compacting the crumpled foil by pressing, and heating the crumpled compacted foil to cause consolidation of the part by bonding and/or sintering. 2. Process according to claim 1 in which compacting and consolidation of the foil are effected simultaneously by hot working of the crumpled foil, e.g. by rolling, pressing, extrusion, etc. 3. Process according to claims 1 and 2 in which the crumpled, compacted and consolidated foil product is formed to the shape of the required part by cold working with or without subsequent machining. 4. Process according to claims 1 to 3 in which the foil is of any metal capable of being obtained in the form of foil. 5. Process according to claims 1 to 3 in which the foil is aluminium foil. 6. Process according to claim 5 in which the aluminium foil is provided with a surface oxide coating. (Think of SAP. Inventor's note.) 7. Process according to claims 1 to 3 in which foils of two or more different metals or alloys are used in proportions and combinations required to produce a product having a desired composition and structure. 8. Process according to the preceding claims in which a non-metallic material is introduced in a manner such as to become incorporated with and suitably distributed among the crumpled foil. 9. Process according to claim 8 in which the non-metallic material is a synthetic resin adhesive. 10. Process according to claim 9 in which the synthetic resin adhesive is applied to the surface of the foil to form a coating on one or both sides of the foil before crumpling. 11. Metal parts produced by a process according to claim 1.

Well Chosen IDEALLY, the subject of a research undertaken in pursuance of a doctorate or other thesis should be novel, simple so far as the necessary equipment is concerned, and fundamental, i.e. its results should have no immediate or foreseeable practical value. An example of a subject from the metallurgical field which meets these requirements is that recently studied by a research worker at the Technische Hochschule in Munich, viz. the occurrence of noises during the melting and solidifying of metals. The metals used included commercially pure tin, zinc, lead and mercury, chemically pure bismuth, alloys of aluminium with 10 and 20 per cent zinc, zinc alloys with 0·7 and 1·5 per cent cadmium, and Wood's metal. The equipment consisted of a crucible to which a connecting rod leading to a sound detecting and amplifying arrangement was sealed. The intensities and frequencies of the noises were observed on an oscilloscope and were plotted against temperature. Metals showing a volume expansion during melting (e.g. tin, lead, zinc) were found to melt noiselessly, whereas solidification was very noisy. Metals like bismuth and Wood's metal, on the other hand, which contract on melting, gave rise to a lot of noise on melting, whereas solidification occurred almost noiselessly. The noise-temperature curves provided a means for the very accurate determination of the liquidus and solidus points. The electro-acoustic method thus seems to be an excellent supplement to other conventional tests for determining changes of state or structure. Beyond such applications and the intrinsic interest of the results as such, one may look forward with a fair degree of confidence to the linking of these noises with dislocations. By a process of derivation, one may, presumably, also expect noise diagrams paralleling and throwing useful light on tensile stress-strain diagrams and other processes involving deformations of metals and alloys.

Overlooked CAN progress be too rapid? In science and technology the conventional answer is: of course not. The sooner existing methods and equipment can be replaced by something better, the better, or so it would seem. Strictly speaking, this is so only if the "better" is something which is in direct line of descent, as it were, from that which it replaces. There is less certainty if the "better" is something radically different. In that case, there occurs the possibility of its appearance on the scene destroying the interest, however small, in the further progressive development, however slow, of whatever it is the new arrival replaces with such apparent success. A great deal of confidence and perseverance, a broad and balanced outlook, and a considerable measure of indifference to a risk of "missing the boat" are necessary if one is not immediately to drop using a back number and adopt the latest edition. How much work that might well have yielded useful results has been cut short in this way must remain uncertain. The instances of developments being pursued and, later, significant claims made for their consideration as against the more recent introduction, are few and far between. One such has occurred following the recent publication in America of a "harmless" article on "What It Takes to Weld Aluminium." Since the article was published in a journal devoted to marine engineering, it, not unexpectedly, featured inert-gas arc welding. Somewhat unexpectedly, it called forth two letters from authoritative correspondents drawing attention to a "back number"—metal-arc welding with coated electrodes:—"It is our observation that all of the inert arc-welding methods currently in use in this country for joining aluminium have enough shortcomings to make it almost imperative that other electric welding systems be investigated." "In Norway . . . they have developed a technique . . . based on the extensive use of metal-arc welding with coated electrodes. . . . In spite of all the good that can be said for inert-gas shielded welding, Norway is increasing her lead by leaps and bounds. . . . The Norwegian brand of metal-arc welding is a far cry from that known in this country or anywhere else. The AWS Welding Handbook has not kept up with the times, and its entire chapter on metal-arc welding of aluminium should be cancelled out. Inert-gas welding equipment is too cumbersome and too expensive. . . ." Has progress been too rapid?

Skimmer

MACHINE DEVELOPMENTS — DIE DESIGN — STRESS AND PRESSURE TESTS

Large Aluminium Die-Castings

By A. F. BAUER

Applications of large aluminium die-castings have been increasing throughout the past decade, and the development of very large die-casting machines has contributed greatly towards their wider usage. This condensed version of a Paper given at the Second International Pressure Die-Casting Conference, describes some recent American development in this field.

ONLY a few years ago the first clutch housings and torque converter housings were produced in aluminium die-casting by Doehler-Jarvis. These two parts, with a total weight of 27 lb., were introduced in 1951 and represented then the first large housings exposed to high static and dynamic stresses.

A die-casting machine with a locking pressure of 2,000 tons was completed in 1954, and the first six-cylinder engine blocks, weighing 43 lb., were produced.

Two men on the machine produced a maximum of 35 blocks/hr. While the chilling time was only 18 sec., the total cycle time of 105 sec. was adversely affected by approximately 60 sec. for cleaning and lubricating the large die members. Since the die can be cleaned by an automatic air blow, and lubrication can be accomplished by an automatic spray, it was concluded that the number of engine blocks the die will yield per hour can easily be increased to more than 40.

The six-cylinder is an obsolete design in the U.S. and emphasis is now on the V-8 engine block. Two different solutions of a die-cast V-8 engine block have been completed. As the parts are designed, they do not present unusual die-casting problems. The estimated weight of these V-8 engine blocks is 55-65 lb., and the castings can be produced on Doehler's 2,000-ton machine, which was designed for these engine blocks.

A more serious problem is the design, choice of material and fastening method for the eight wet sleeves which have to be inserted into the aluminium engine blocks to provide the channels for the water cooling system.

With heavy undercuts, many designers felt that the transmission case could never be redesigned for aluminium die-casting, but this has been done. One of these large transmission housings, which actually combines the transmission case and the bell housing in one casting, has a weight of 15 lb. aluminium and is produced at a rate of 50 shots/hr. In order to beat grey iron and aluminium gravity castings, the wall thickness has been reduced to a minimum of 0·150 in., taking full advantage of the high fatigue strength of aluminium die-casting. All holes are cast to close tolerances and machine stock is held at a minimum. Similar transmission cases, with weights up to 30 lb. and made in one piece, are now being tested or are still in the design stage. These transmission housings alone may increase the consumption of aluminium by 40,000 tons per year.

Machine Developments

Since die-casting machines for these large castings were not available, the machine builders hurriedly opened up a new line of large die-casting machines with 1,000-ton and 1,250-ton locking pressures.

A 1,250-ton die-casting machine developed and built by Doehler-Jarvis for the production of the "Turbo-Glide" transmission housing uses a parallel toggle system with a maximum opening of 30 in., and has a locking pressure of 1,250 tons. It is designed for a maximum casting weight of 40 lb. aluminium and develops an injection pressure of up to 8,000 lb/in^2 on the metal. It is operated by hydraulic water from a central station with a line pressure of 1,500 lb/in^2. The molten metal is held in a large gas-heated reverberatory furnace with the ladling well very close to the shot sleeve.

This machine can be operated by hand, semi-automatic or completely automatic. Hydraulic ejection and four different core pull systems are included in the automatic cycle. The machine is equipped with automatic lubrication, automatic controls for metal temperature and die temperature.

Cast-Master's largest die-casting machine, with a locking pressure of 1,200 tons, has a tie bar distance of 72 in. by 63 in. and tie bars of 10 in. diameter. The sliding plate is locked with a pair of toggle links which give a maximum die opening of 34 in. For faster adjustment of the machine, the large nuts at the end of the tie bars are simultaneously driven by an electric motor on top of the machine. It is claimed that this mechanized drive is not only much faster, but gives a more uniform adjustment than the old hand method. The shot end carries an intensifier which increases the injection pressure as soon as mounting resistance slows down the filling of the cavity.

It is a self-contained unit operating with an oil-hydraulic system whereby pumps, accumulators, valves and piping are attached to the base of the machine.

The large Doehler 2,000-ton die-casting machine, on which the engine blocks are produced, accommodates castings up to 75 lb. in aluminium by the use of a 6 in. sleeve and a shot stroke of 36 in. With a hydraulic line pressure of 3,500 lb/in^2, it develops a maximum injection pressure of 7,000 lb/in^2 on the metal. It can accommodate the dies for the largest V-8 engine blocks for passenger cars.

Mechanical Ladling

One of the biggest disadvantages of the cold chamber method is that the metal has to be ladled by hand, not only because of the fatigue and slow-down of the operator, but also because of the variables of hand ladling and their adverse effect on the casting quality.

It is extremely difficult to imitate and replace by mechanical means the smooth motions of hand and arm of an operator during the ladling process. These automatic ladles at best came up to the hand performance, but created many additional problems and breakdowns, not heretofore known in the hand ladle. Therefore, on small and medium-size machines, and even up to castings of 10 lb., preference is still given to the hand ladle. In the United States, the automatic ladle is installed and operating economically only on a few large die-casting machines.

For large castings of 15 lb. and more, however, ladling by hand becomes a serious fatigue problem and has an increasingly adverse effect on the speed of operations.

The Ajax Engineering Corporation uses an automatic pouring unit called "Ajaxomatic," whereby the metal is poured into the shot sleeve through a ceramic pipe which is submerged in an induction-heated metal bath. Pressure on the surface of the molten metal forces the metal through the pipe into the shot sleeve, and an adjustable timer meters automatically the amount of metal to be poured. Several of these Ajaxomatic pouring units are in operation on medium size die-casting machines.

An automatic ladling unit developed by the Lindberg-Fisher Division of the Lindberg Engineering Company operates on the principle of a pressurized chamber, the size of the shot depending upon both the time of pressure application and the pressure. All parts of this unit which come in contact with molten aluminium are

made of high-grade special refractory materials. Since there are no moving parts, this ladling device operates very satisfactorily.

A relatively simple pouring ladle, well suited for extremely large castings, is, in effect, a small holding furnace, electrically heated and temperature controlled, with a metal content larger than that of the maximum shot. A contact switch starts tilting the ladle as soon as the die is closed. The amount of metal poured into the shot sleeve is controlled by the angle of tilting and by a timer. When the ladle turns back, a switch initiates the injection of the metal into the die.

This system pours the metal right after closing of the die, without delay, and can handle large amounts of metal up to 100 lb., or even more. A 60 lb. charge of molten aluminium was poured into the shot sleeve within 7 sec. It can be charged with metal while the die-casting machine is in the opening position, either by hand or automatically.

The large die-casting machines mentioned are also well suited for magnesium die-casting, if they are equipped with a ladling device for magnesium. Such an automatic metering device for magnesium, which can be attached to horizontal cold chamber machines, has been developed and successfully demonstrated by the Dow Chemical Company. This automatic pouring unit increases the speed and efficiency of the casting cycle so much that, at least, large magnesium castings may be produced more economically on the cold chamber machines than on the hot chamber machines.

Die Design

Generally speaking, the design features and problems on large die-casting dies are the same as on smaller dies, with the only difference that handling, maintenance, breakdowns and corrections are so much more time-consuming and costly. The difficulty of producing castings of acceptable quality, and at dimensions within agreed tolerances, is much greater. Gating and venting of the dies are more difficult, and shrinkage variations affect large castings much more than small ones. The preparatory work in determining tolerances, machine stock, taper, core pulls, etc., has to be much more thorough.

The die for the Doehler-Jarvis six-cylinder engine block has a cover die 12½ in. thick and weighs 8 tons. The ejector half is 22 in. thick and weighs 16 tons. The total weight of the die, with ejector system and core pull, is 30 tons and its overall dimensions are 146 in × 145 in × 42 in.

The biggest problem with such a large die is to find Kellering machines, die-making equipment and crane facilities large enough to handle, machine and assemble it. The largest Doehler die-cutting equipment was much too small, and even for most American large die shops these die blocks were too big to handle. If eight-cylinder engine blocks go to aluminium die-casting, the bottleneck will not be the die-casting machines, but most likely the die shop facilities for these large dies.

The steel for these large dies presents a problem in itself. All large dies have been designed for set-in impressions in large holding blocks. The holding blocks are cast steel. For the impression blocks, hot work steel is used with an approximate composition of 5 per cent chromium, 1 per cent silicon, 1 per cent vanadium and 1 per cent molybdenum. Making the impression from many small pieces instead of one large piece of impression steel somewhat increases the initial costs of the die because of the extra time for fitting, but presents many advantages. For large dies such as this, a one-piece forged impression block of high quality is most difficult to produce with the largest forging presses. Moreover, large blocks are often not forged thoroughly enough and, therefore, do not represent highest quality steel. More important, an impression split into a number of smaller steel blocks drastically reduces the stresses which develop in large die blocks resulting from the difference in temperature in various parts of the die block. Cleavage cracks—so dangerous in large die blocks—can be avoided by using smaller pieces.

The advantages of the split design of impression blocks are so outstanding that several disadvantages are accepted and taken into account. One of them is that the water cooling of many small pieces becomes a more difficult problem. In this particular die, a total of more than 50 separate water inlets and outlets had to be connected and the water flow properly adjusted. In order to prevent a repetition of this adjustment of the cooling water every time the die is set up, all hoses are attached to a manifold which, once adjusted, stays with the die.

A somewhat smaller die for a transmission case, weighing 18 tons including core pulls, has four side cores; one of them is very large, with a projected area of 270 in^2 and a stroke of 26 in. Since the metal is injected with 7,000 lb/in^2, this slide has to be locked with 1,890,000 lb., or 945 tons, which is almost as much as the total locking pressure of the 1,250-ton die-casting machine on which this housing is produced. The locking and core pull arrangement for this large slide presented the most serious design problem of this die. It has been solved by a large wedge-lock arrangement in the cover die and two internal locks in the ejector die.

There are some 60 small cores of ½ in. diameter or less, attached to the three large slides. Most of these small cores are arranged so that they can be interchanged in the die without taking the large cores out or disassembling other sections of the die. This interchangeability of small cores, and even ejector pins, is most important. Since they fail more frequently, they would cause long breakdowns and tremendous expenses if they could not be replaced in the die.

On these large castings very careful attention is given to the basic parting line, the gating and venting of the die, the core pull arrangements, overflows and flash control. The old "hit and miss" practice, to start with a thin gate and gradually open it up by adding new runners and welding up others, is extremely costly on large dies. The size of the gate, therefore, has to be computed, based on the expected filling time, and the best gate location determined using experience on similar parts in order to reduce the number of die settings and gate corrections to a minimum.

Stress and Pressure Tests

Since it is extremely difficult to compute with any degree of accuracy the combined static and dynamic stresses in such large housings, experimental stress analysis is often used as a rapid means to determine the location of highly stressed areas and the magnitude of the stresses.

As the first phase of the stress test, stress coat lacquer is applied at all regions of the casting which can be visually inspected. Since this coating becomes brittle upon drying, it will crack when the coat's surface elongates. Stress coat patterns first appear at areas of maximum stress, so that regions of stress concentration become evident as the test load is gradually increased. When these areas of high stress concentrations have been determined, electric strain gauges are placed normal to the direction of the stress coat pattern.

This procedure usually makes design modifications clearly evident, so that much guess work and "trial-and-error" methods can be avoided. On highly-stressed parts for cars, these strain gauge tests are repeated in a road test for stress measurements under actual operating conditions. Together with rigidity tests, this is the best method to hold the weight of structural parts at the lowest minimum and still maintain the necessary factor of safety. Material is added and sections changed only in highly-stressed areas, thus avoiding the addition of material and weight where it is not necessary. These tests commence with sand castings, so that major corrections in walls and shape can be incorporated before the cavity of the die is cut. In most cases, only minor modifications are necessary when the tests are repeated with the first samples from the die-casting die.

Aluminium hot chamber castings produced 30 years ago on low pressure air machines, had an extremely thin skin with porous centre sections sometimes so large that the castings would

float on water. The cold chamber machine brought quite an improvement and still is improving the density of die-castings by gradually increasing the injection pressure. The higher the injection pressure, the longer it can be transmitted through the still molten centre section of the die-casting wall, the thicker and denser will be the outside layer. High injection pressures, therefore, produce denser and stronger castings.

In some cases, injection pressures have been increased to 20,000 lb/in^2 and more. It may be assumed that the pressure which produces the highest physical properties varies from casting to casting, and may depend on the filling conditions resulting from the shape of the cavity.

Higher injection pressures necessitate heavier die-casting machines and dies. They cause more breakdowns and have an adverse effect on the overhead costs of the die-casting department. It is, therefore, only reasonable to suggest that high injection pressures be applied only where the quality of the casting requires it. At present, commercial aluminium die-castings in the United States are produced with metal injection pressures between 3,000 and 10,000 lb/in^2, with the largest portion of them using pressure close to 5,000 lb/in^2.

The concept of die evacuation as an aid to the pressure die-casting process is not new. Many ingenious devices have been built and patented in the past, but none of them has offered enough improvements to justify the additional problems of vacuum-seals and their maintenance, especially on intricate dies with side cores.

Recently, however, a vacuum method was advanced whereby the casting die is enclosed in a metal box which is sealed and evacuated every cycle when the die is closed. The novel feature is that this box acts as an accumulator all during the shot, continuing to extract gas, which is generated by vaporized lubricants or other sources. With this method, a partial vacuum of 18 in. mercury is obtained.

It is claimed that this vacuum process on zinc die-casting machines reduces porosity, improves surface finish and physical properties, simplifies gating, increases operating safety, and reduces minimum injection pressure.

For aluminium cold chamber machines, the application of a vacuum method is a more involved problem, since the metal in the shot sleeve also has to be evacuated. Several different vacuum methods for cold chamber machines are under development One of the principles used is to suck the molten metal out of a metal pot through a vertical tube into the shot sleeve.

Test results and production experience have shown that it is extremely difficult and costly to maintain in the die a vacuum of less than 15 in. of mercury. Under these conditions, the air in the cavity is only partially evacuated. Therefore, porosity caused by entrapped air can only be reduced, not eliminated. Voids in heavy sections resulting from shrinkage conditions will not be reduced at all by any vacuum system. The vacuum system, therefore, is not a "cure-all" for all of our die-casting problems.

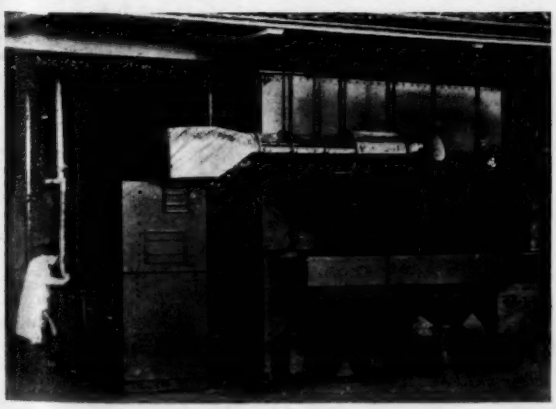
Dust Control in Metal Spraying

ZINC and aluminium metal spraying are practised by Woods of Colchester in their production of axial flow fans at Colchester. This operation is carried out in booths whose location relative to other activities called for a very high degree of dust and fume control. Bag filters had been originally employed for dedusting the exhaust air from the booths but, whilst reasonably economical performance was attained with aluminium spray dust, the extremely acicular nature of zinc particles gave rise to such a rapid increase in pressure drop across the fabric, allied with an ability to cling to the fabric even under conditions of vigorous bag shaking, that the cost of a filter installation capable of satisfying production requirements was prohibitive from capital, running and space considerations. The problem posed to Dallow Lambert and Co., as specialists in dust control and collection, was to provide a deduster capable of satisfying the requirements economically. The solution was derived through two principal fields of assessment—the physical properties and behaviour of aluminium and zinc dusts, and the geographical limitations of the site.

Three methods of dedusting were available—cyclones, fabric filters and wet dedusters — and the collection efficiency obtainable with all three types was calculated following an accurate size analysis of the dusts involved. Cyclones were precluded by their relatively low efficiency, and fabric filters were inacceptable for the reasons defined above. A careful evaluation of wet dedusting was undertaken, therefore, and it was found that whilst the efficiency obtained with a wet deduster would not be as high as that theoretically obtainable from a fabric filter, because of the unique primary and secondary dedusting systems employed, the effluent anticipated from a Dallow Lambert wet deduster would be sufficiently dilute to allay fears of secondary problems associated with atmospheric pollution by dust and fume. Critical tests were carried out in the company's pilot plant laboratory and a Dallow Lambert wet deduster (series MG, type C) was recommended for this application, manual sludge removal methods being recommended, bearing in mind the relatively low volume of dust entrained within the system.

This plant was installed and, at the suggestion of Woods of Colchester, axial flow fans of their own manufacture and design were employed in place of a multiblade centrifugal fan. This allowed an exceptionally neat and compact arrangement of outlet header and fans to be obtained. A further refinement necessary for use with aluminium metal spray collection was the venting to free atmosphere of any incipient hydrogen generated through the immersion of the collected fine particles in water, the hydrogen concentration within the unit being kept to safe limits; a non-return valve in the air inlet duct prevented any contamination of workshop atmospheres. It is informative to note that the area occupied by the wet deduster is just over 5 per cent of that necessary for a fabric filter of equal capacity.

The plant has been in commission for some time now and is proving satisfactory from all aspects—dust control, dust collection, efficiency, maintenance and running costs. The accompanying illustration shows the wet deduster in service; adjacent is the fabric filter which proved inadequate for the same duty.



The Dallow Lambert series MG, Type C wet deduster (left) with the fabric filter which it superseded alongside on the right

CURRENT DEVELOPMENTS AT STAR ALUMINIUM COMPANY LIMITED

Foil Laboratory Developments

NEW applications of aluminium foil have led to an increasing demand for high-quality material, and the Star Aluminium Company Limited, producing in twin factories at Bridgnorth and Wolverhampton, carry out constant research in order to improve the quality of their foil for these new applications.

The casting of sound homogeneous billets and slabs from melted aluminium ingots is the first stage of production. Strict quality control in this process is the secret of producing first-class quality foil for multi-colour refining.

Spectroscopic analysis is a constant check on this basic point, and spectrograph and microphotometer are used. The Judd Lewis comparator allows detailed comparison of spectrographic plates in a simple manner.

Metal producers use a direct-reading spectrograph where it may be fully employed giving continuous analyses on a large scale, but the principle employed is the same.

In the production of foil, "scalping" the surface layers formed during the hydraulic operated semi-continuous melting process prepares slabs for hot rolling.

The slabs are reduced to strip and foil in hot and cold rolling mills down to 0·00017 in.-thick. Experienced roll operators maintain a high quality output, and continuous contact mechanical micrometer gauges are a guide to the ±8 per cent consistency generally required. Non-contact electronic type gauges are used on the thinner gauges down to 0·004 mm. Metallurgical quality is ensured by constant laboratory control.

Weighing, measuring, analysing—testing for hardness—checking tensile strength, studying grain structure of the foil, all form part of the responsibilities of the metallurgical laboratory.

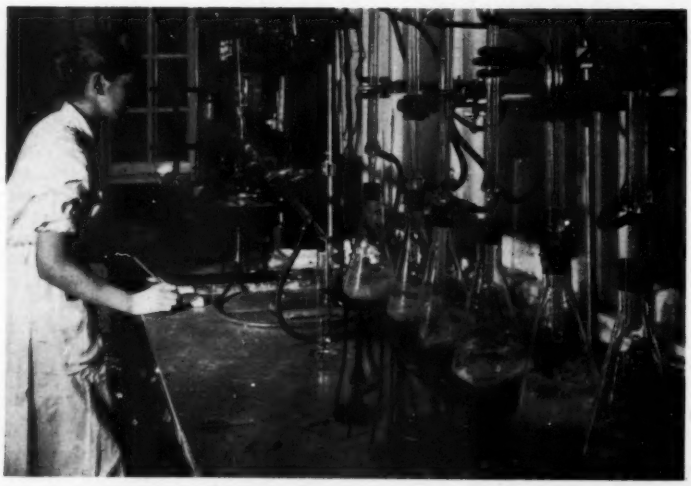
Producing good aluminium foil is, in itself, a quest for perfection, and the standard achieved must be matched in the laminating, coating, colouring, embossing and printing which may follow.

High-speed laminators—laminating foil, paper or film — must have adhesives of a high quality maintained by the chemical laboratory.

Isotope controls are used for observing thickness consistency of coatings. Similarly, research is carried out into colour combinations and matchings, which are carefully regulated to ensure a consistently high standard.

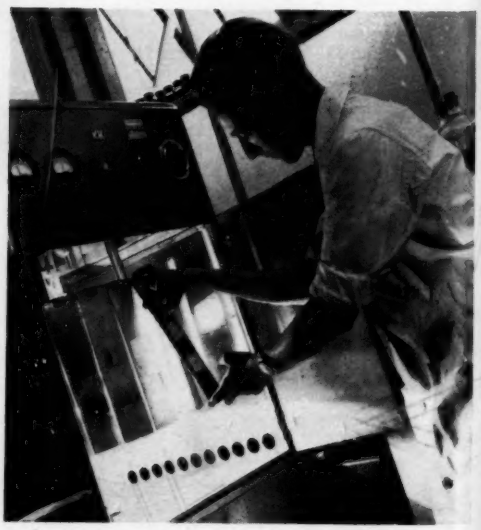
Fade tests are carried out by examining samples which have been exposed under varying conditions. Studies are also made of lacquers, inks and dyes to enable advice to be given on their use to converters who wish to obtain the maximum from printed foil.

Electronic print register controls installed on multiprint rotogravure machines, which print the foil, make automatic corrections at high speed. Electronic devices also enable the print to be studied as though stationary—by "scanning" at high speed.



Top left : Distillation range test of lacquer solvent

Bottom left : Colour matching to ensure high colour printing standards



Below : Examining fade test samples

Finishing Supplement

Platers' Forum

EVER popular among Midland platers, an open discussion under the title "Any Questions?" provided a most interesting evening at the December meeting of the Midlands Centre of the Institute of Metal Finishing.

Opening the meeting, Dr. D. N. Layton, chairman of the Midlands Centre, said that it was three years since the last "Any Questions?" session had been held in Birmingham, and in handing the chair to Mr. Cyril Wharrad (Britachrome Ltd.), who was responsible for organizing the meeting and who would put the questions to the audience, he felt sure that they could expect an informative and useful discussion.

Before putting the first question to the meeting, Mr. Wharrad said that in his opinion meetings of this kind could be of practical assistance to everyone connected with the plating trade—outworker, chemist and even the supply houses—provided only that they all took a free part in the discussion.

Question I—

What is the best method of drying out small nickel-plated pins, eliminating stain but without the use of cyanide swill or sawdust?

Mr. A. W. Wallbank was of the opinion that most staining problems from barrel nickel plating, assuming rinsing to be satisfactory, were due to insufficient nickel deposit, and suggested that the deposit thickness should be increased.

Mr. S. R. Bettridge, who had submitted the question, said that he considered the deposit thickness he obtained satisfactory for the type of work he was processing, and satisfactory results could be obtained if a cyanide dip was used, but this he wished to avoid.

Dr. Layton queried the reason for avoiding cyanide and asked whether or not cream of tartar had been tried?

Mr. Bettridge replied that the use of cyanide added to his effluent problems, but produced a whiter finish than cream of tartar or any other rinse he had tried.

Mr. L. S. Lowery said that hot rinses made stain-free drying difficult, and suggested drying from a cooler final rinse.

In reply, Mr. Bettridge said that he was using cold final rinses.

Mr. Neale spoke of acid versus alkaline rinses, but considered a cyanide dip prior to final rinse to be most suitable for this class of work.

Confirming that a cyanide dip was most satisfactory, Mr. Wallbank said iron contamination of the nickel solution also contributed to staining.

Summarizing, Mr. Wharrad stated that it appeared to be the opinion of the meeting that a cyanide swill was the most satisfactory method.

Question II—

We are experiencing considerable trouble with "spotting out" in bronzing steel rod used for hearth furniture implements. Is there an answer to this problem?

A number of the members present said that poor base material was most probably the cause.

One speaker suggested stoving at 200°C., Mr. Neale proposed alternate hot and cold rinses, followed by a cream of tartar dip prior to final hot water rinse, while Mr. J. W. Dove suggested a dichromate dip.

Mr. J. G. Kitchen, who had submitted the question, said that all the suggestions made had been tried and failed.

In view of the fact that suggested methods had failed, Mr. Wharrad said that it appeared that a better quality base material would prove to be the answer to the problem.

Question III—

Why is it that thick specification plating cannot be obtained by barrel plating methods?

One speaker said that if surface areas were correctly calculated and the time cycle necessary to allow for the efficiency of barrel plating was given, satisfactory results would be obtained.

Dr. Layton pointed out that any specification could be met; it was purely a question of cost.

Mr. Neale remarked that when heavy articles were barrel plated, the burnishing action might remove or tend to prevent deposition on high spots.

Mr. Bettridge agreed a good average deposit could be obtained, but doubted the economics of meeting the minimum of specification in the centre of a mass of very fine work such as straight pins.

Mr. Wharrad said that the problem of scatter always arose with specification barrel plating.

Mr. Wallbank did not agree with the suggestion that the deposit was rubbed off the high spots, but problems were met due to impoverished solutions, particularly when inclined barrels were used, and specification plating was best obtained from immersed units.

Mr. S. Dawson, referring to the enclosed barrel, said that to meet specification plating economically, a barrel with the maximum permissible sized hole should be used, and where a large variety of work was processed a number of units should be kept with a range of hole sizes, and the appropriate barrel used.

Mr. C. R. Darby said that barrel processing based on weight and time was incorrect; surface area and current consumed should be the basis for calculation of time required.

Mr. W. P. Jeffs remarked that it was practically impossible to obtain deposits in excess of 0·0002 in. on flat spring clips in a semi-immersed barrel.

A problem often met with in specification barrel plating, said Mr. S. W. Baier, was the build-up on the extremes of articles before the required thickness was obtained in the centre.

Dr. Layton commented on bright nickel deposits breaking off when heavy deposits were required, and said great care was needed in choice of control of solution.

Mr. P. Green stated that heavy barrel nickel deposits were best obtained from dull nickel barrel solutions.

Question IV—

Is there any way of barrel plating articles long in proportion to the diameter without getting unduly thick deposits on the end and very brittle in the middle?

Mr. Bettridge said that best results would be obtained with a high conductivity solution and a low current density.

Question V—

What is the best workshop test for checking the thickness of barrel zinc plating?

Mr. N. A. Tope asked if a method had been developed by Dr. Clarke similar to the gassing test used for cadmium.

Mr. Wallbank replied that Dr. Clarke had not developed a method for checking zinc, although this had been mentioned several times as a possibility by Dr. Clarke.

Referring to a Paper on this particular subject which was presented in London, Dr. Layton said the make-up of the hydrochloric acid-antimony trioxide solution was very critical, and he was pessimistic about an accuracy of ±20 per cent with the use of same. Hydrochloric acid was not reliable and he did not consider the jet test developed by the British Non-Ferrous Metals Research Association to be a practical workshop method, particularly on very small component parts.

Mr. Wallbank spoke of a comparative test where gassing times were checked on a piece of wire on which a

known thickness of zinc had been deposited, and gassing times were compared with the component undergoing the test almost simultaneously.

Question VI—

What is the effect of anode to cathode distance on throwing power in a chromium plating solution?

Theoretically, said Mr. J. M. Sprague, it was the same as in any other solution, but in practice insufficient attention was given to the operating conditions. Agitation and filtration, which were universally practised with nickel solutions, were seldom considered with chrome solutions.

A speaker remarked that the rate of solution change at the cathode face was important to the rate of plating.

Mr. Green said that, presuming anodes and cathodes to be flat, the results obtained at a given current density would be the same, irrespective of the anode to cathode distance.

Dr. Layton pointed out that on flat articles with flat anodes a more even distribution of current was gained if the anode and cathode distance was small; edge effects were more pronounced when the anode to cathode distance was increased.

Mr. Tope described experiments carried out where the cathode was enclosed in a three-sided box and the anode had been placed at the back of the box, and also experiments with anode to cathode distance up to 6 ft. He concluded by saying that, although it was against theory, better throwing power was obtained with short anode to cathode distances.

Question VII—

What causes nodules in hard chrome deposits?

Iron dust was a contributory factor, said Mr. Tope, and he had on one occasion reduced nodular growth caused by iron dust with the aid of a magnetic separator.

Mr. Sprague remarked that nodule growth formed by many conducting particles settling on the article being treated; in addition to iron dust, he mentioned lead chromate and lead dioxide, which he had found to be present in formed nodules.

All the factors previously mentioned were contributory factors, said Mr. Wallbank, as also were high current densities and scratches and damage to the base material, etc. There appeared to be a great number of causes but very few cures.

In answer to a request for further details of the magnetic separator, Mr. Tope replied that at the time the iron dust in his solution was abnormally high, due to the particular job he was processing. The actual method he had used was not suggested for general application, but many platers do have trouble with iron dust and the same principle could be used. Mr. Tope then continued to outline how he had circulated the chrome solution over a magnetic separator.

Mr. Sprague said that it was obvious the problem could be overcome in the same way in which similar problems had been met with in other solutions, namely, by agitation and filtration, but Dr. Layton queried if any one knew of a suitable filter unit and pump for this purpose.

Question VIII—

How many platers have replaced fume extraction on chrome vats by a proprietary fume eliminator? What are the real advantages of the latter?

Information gained from the members present suggested that about 10 per cent were using "Zero-Mist."

Mr. Tope approved of its application in bright chromium solution from the efficiency point of view but queried the economics.

Mr. C. A. Leatherbarrow said that it depended on the solution and operating conditions. It was not suitable for use with high temperatures, or fluoride-containing solutions.

Mr. Kitchen was of the opinion that, apart from its intended use, it lowered the passivity of nickel deposits in the chrome solution.

Mr. K. E. Langford queried the cost and selling price of the preparation.

Mr. Wallbank said that in spite of the high cost it was worthy of serious consideration. It was known that more chromic acid was drawn up the ducts than was used for plating. This, in turn, created untold damage to roof structure and guttering of the factory building. A fan could always be installed as an additional safeguard.

Mr. J. P. Bouckley said that his company had used it for some considerable time and were completely happy with it.

Mr. Lowery said that Zero-Mist was not recommended for use with hard chrome solutions, as gas bubbles tended to form pits. With regard to the price, he said a considerable amount of money had been spent in the development of the material and the cost of production was high. He thought, however, that there would be a reduction in price if the sales increased satisfactorily. He stated there were 250 firms using this preparation in the British Isles at present. Instances had been cited where a reduction of 50 per cent chromic acid had been effected with the use of Zero-Mist. In addition to advantages mentioned, a considerable reduction of heat losses via extraction had been gained.

Mr. R. Fyfe said that the material had been referred to as a wetting agent which reduced surface tension and dragout losses. If this was so, one would expect these properties to eliminate pitting caused by hydrogen bubbles, not cause it, as suggested by the previous speaker.

Dr. Layton confirmed that pitting did occur in hard chrome deposits. In answer to the previous speaker, he said the material decomposed with high temperatures and suggested this as a contributory cause to pitting in hard chrome solution.

Mr. Leatherbarrow agreed with Dr. Layton regarding decomposition being due to high temperatures, saying this had been borne out in practice.

Mr. Lowery said it was expected to have a new type of Zero-Mist available soon for use with the hard chromium plating process.

Question IX—

Knowing that it is essential to cyanide copper plate zinc-base and ferrous metals prior to acid copper plating, what (if any) are the advantages offered with bright acid copper plating solutions?

Mr. Bouckley said that the main advantage was in the smoothness of deposit; roughness in the deposit was seldom encountered.

Mr. N. Christie remarked that advantages were best expressed when a specific application was dealt with, and put forward the following points for consideration as compared with the high speed cyanide copper.

(1) The solution was operated at room temperature, as compared with 160°-180°F. for high speed potassium salt solution. He stated that at this low temperature the rate of deposit was equal and heating cost had been saved.

(2) From the efficiency point of view, the bright acid copper solution was consistently stable, whereas the efficiency of a cyanide solution fell as the carbonate content increased, and continual additions of cyanide had to be made to replace decomposition by heat and agitation.

(3) Heavy deposits could be applied to components with a suitable surface condition at commencement and transferred satisfactorily to a bright nickel vat, whilst heavy deposits from a cyanide solution generally required intermediate polishing for optimum results.

(4) The solution produced deposits economical for polishing where the technique of gaining a high degree of lustre was obtained by buffing the copper deposit instead of the base material.

(5) Operating conditions were clean, non-toxic and comfortable without the use of an extraction plant.

(6) Reduction of effluent problems.

Mr. Tope queried the throwing power when plating recessed steel or zinc-base castings after a cyanide copper flash.

Dr. Layton doubted the reduction of effluent problems when a cyanide flash deposit was used.

Mr. Christie replied that the coverage on flash cyanide deposit was extremely good, and problems had not been met due to penetration of the solution to base metal on very deeply recessed articles. In many instances excepting on die-castings, a nickel flash

instead of cyanide copper could be used. In reply to a speaker who asked if the deposit was suitable for bronzing afterwards, he replied that pleasing bronze shades could be obtained, but colour was not so easily controlled as on dull cyanide copper solutions.

Mr. F. Wild said the levelling properties of the solution produced deposits of mirror reflectivity on prepared bases, and simplified buffing considerably on unprepared or rough polished base materials.

Question X—

What are the advantages and disadvantages of moving coil meters over moving iron?

Mr. W. F. B. Baker said that it was difficult to state the advantages of one unit over the other as it depended rather upon the application.

The moving iron was suitable for use up to 500 amp, although the reading was cramped at the lower end of the scale and small amounts of current were difficult to read. The meter had to carry the whole of the current, and it was not practicable for current consumption in excess of the figure stated. The reliability of the meter depended on the quality, which was generally in accordance with the cost.

The moving coil meter was a small unit operated by a permanent magnet. The dial was a linear scale and it was suitable for current of any magnitude, because the current passed through a short resistance and the ammeter was really a calibrated millivoltmeter. The smaller amounts of current consumed could be read more accurately, due to even scale reading, and reliability again generally depended on the cost of the meter.

Mr. I. T. Watkins considered the moving coil to be a better unit; it was generally more accurate because workmanship was usually of a higher quality than that involved in the moving iron meter. The cost was also generally higher.

Mr. Baker remarked that a longer life was generally obtained from a moving coil meter, which was less likely to become overheated.

Question XI—

Have germanium rectifiers any advantage over oil-cooled selenium rectifiers?

Mr. Tope said that a friend of his in the United States claimed excellent results from a unit used for anodic treatment of aluminium where high voltages and comparatively low current densities were employed.

Mr. Baker said that slightly better regulation was possible, and agreed satisfactory results would be obtained where the voltage was high and the current density comparatively low.

Mr. Wild stated that the smallness of the rectifier as shown in advertisements was very misleading. The unit termed a rectifier in this country was a combined transformer and rectifier with necessary cooling equipment. Saving in size could, therefore, only be made on a small part of the unit, and the reduction of size of the overall unit was negligible.

Mr. Watkins remarked that the selenium rectifier, oil-immersed and totally enclosed, had proved itself to be a very reliable piece of equipment for the plating shop atmosphere.

Mr. Baker agreed with the previous speakers, saying the low thermal mass of the germanium rectifier made it vulnerable to overheating and overloading. Any accidental short circuits and the unit would quickly break down. Automatic cut-off could be fitted to avoid damage to the rectifier, but platers realized only too well what happened when the current was cut off in the middle of processing. A small pilot unit, he said, could be installed to permit a low current density flow in the event of the main unit being cut off by accidental short circuits.

Mr. Wharrad did not think that short circuits or accidental overloading happened very often.

Mr. Lowery said that information from U.S.A. showed that it happened very often and had been a continual source of trouble where germanium rectifiers had been used.

Mr. Wild said there were many selenium rectifiers in the country to-day almost continually overloaded, and whilst this practice was considered very wrong it pointed to the tolerance of this type of rectifier.

Question XII—

Could the meeting please state the most economic and efficient form of tank heating; also, is it worth while lagging tanks?

One speaker suggested heat exchangers with steam or high pressure hot water.

Mr. Lowery said that lagging was not as efficient as might be expected, due to heat losses from the top of the solution.

Mr. Darby was of the opinion that gas was the most economical if the plant was correctly designed with an outer jacket, with heating space between this and the tank, the outside being lagged with asbestos. He said that where steam was used it was advisable to maintain steam traps in good condition, otherwise steam losses were considerable.

Mr. Bettridge queried the efficiency of heat exchangers where high temperature solutions were required, suggesting that the heat loss due to circulation would lower the efficiency.

A speaker asked for brief details of the working principle of heat exchangers.

In reply, Mr. Darby explained that the heat exchanger consisted of a carbon block which was honeycombed in two ways, one for the passage of steam, the other for circulation of solution. The heat conductivity of carbon was very high, and it was an ideal chemically inert medium for the heat transfer. He added that they did not occupy valuable space in the vat.

Mr. Wallbank pointed out that the efficiency would be lower where circulation of the solution was not normally employed, but was necessary only because a heat exchanger was used.

Mr. C. M. Postins said that the efficiency of the units was very high, but up till recently installation on small tanks had been costly. He stated that small units were now available.

At the close of the meeting, Mr. G. Vaughan said he would like to enlarge on the interesting remarks made by Mr. Watkins regarding the suitability of oil-immersed copper selenium rectifiers as opposed to the more recent germanium rectifiers, and the corrosive atmosphere to which electrical apparatus was subjected.

The plating shop atmosphere is the cause of many plant failures, as not only are the work rods on the vats affected but, more frequently, the switches on resistance boards become so encrusted with a high resistance film that platers have been seen to pour a drop of solution over the switches to get current to pass.

Similar faults occur on the knife switches and change-over switches, and although new plating shops were being built and new plant installed, it is surprising to find that more modern electrical equipment is still shunned.

Remote controlled resistance boards —single pole switches, double pole switches and change-over switches are all available to the trade and can be installed away from the immediate vat atmospheres and require very little attention.

Although some members were of the opinion that these electrically-operated switches were far too costly, other members who had installed this type of gear were quite satisfied with their performance.

Most types of electrically-operated gear were offered at very competitive prices. In their own interests, it was hoped that more people would see the advantages of, and install, modern equipment.

Obituary

Mr. W. W. Franklin

IT is with regret that we record the death of Mr. W. W. Franklin, M.I.Mech.E., technical director of Davy and United Engineering Company Limited. Mr. Franklin served his apprenticeship and entire industrial career with the company. In 1931 he took charge of the estimating drawing office, later becoming rolling mill department manager and proposal manager. In July, 1947, he became chief engineer, and in 1951 was appointed to the board of the company as technical director. He was a member of the Rolling Mill Plant Committee of the British Iron and Steel Research Association.

PROCESS FOR SOLVENT EXTRACTION FROM ACID LEACH LIQUORS

Extracting Uranium

A CONTINUOUS counter-current process for the solvent extraction of uranium from acid leach liquors at the Shiprock, New Mexico, mill of Kerr-McGee Oil Industries Inc. was described recently at a New Orleans meeting of the American Institute of Mining and Metallurgical Engineers. The process utilizes di (2-ethylhexyl) phosphoric acid and tributyl phosphate dissolved in a high flash-point kerosene to extract uranium from the acid leach liquor. The uranium laden solvent is stripped with a 10 per cent sodium carbonate solution and the barren solvent returned to the extractor. The uranium-bearing carbonate liquor from the stripper is acidified and the uranium precipitated with ammonia or magnesia.

In determining the particular solvent to use, consideration was given to the amines, the mono alkyl phosphate and di (2-ethylhexyl) phosphoric acid. Of the many possibilities, the Oak Ridge "Dapex" process, using di (2-ethylhexyl) phosphoric acid, had one outstanding virtue—the solvent was already available in commercial amounts at an established price. All other solvents were available only in experimental quantities. Although the Dapex process possesses other qualifications for the feed liquors, this particular one of solvent availability was decisive.

This solvent technique and process were developed in the Oak Ridge National Laboratory in the Raw Materials Chemistry Division; much of the work has been published[1].

In the application of the process at Shiprock no significant deviations were found from the published data, and estimates made from laboratory tests have been closely verified by actual experience in the production plant. A schematic flowsheet of the process is given in Fig. 1.

Equipment

In the Dapex process the acid liquor must be relatively free of ferric iron since this element is extracted to some extent under the conditions used for uranium recovery.

The reduction of ferric iron to ferrous is accomplished by passing the acid liquor from the thickener overflow through a bed of scrap steel shavings which are purchased from machining operations. These steel shavings are loosely packed to a depth of 6 ft. in a 5 ft. diameter wooden tank having a false bottom. The solution flows into the bottom of this tank, rises through the steel shavings, and is reduced in its upward passage.

By ensuring that there are always enough shavings and that fine material does not clog the tank and cause channelling, the reduction of ferric iron is easily and cheaply accomplished. It has been found by experience that if the liquors are reduced to an emf between 275 and 300 mV, substantially no iron is picked up in the solvent extraction circuit.

The extraction section is composed of four mixer settlers arranged in a cluster. The mixer-settlers differ in elevation from one unit to the next by 1 ft., so that the aqueous phase flows by gravity, while solvent is transferred uphill from one stage to the next by air lifts.

The design capacity of the extraction unit is for an aqueous flow of 120 gal/min. which is the liquor produced from 350 tons of ore/day. At this capacity, solvent flow was to be a maximum of 40 gal/min.

Each mixer-settler stage comprises one wood stave tank on concrete piers, 16 ft. diameter by 6 ft. deep, and a stainless steel mixing tank, 4 ft. by 4 ft., placed on legs inside the settler against the wall. The major purpose of placing the mixers inside the settlers was to facilitate piping, since connections between mixer and settler are achieved by holes cut in the wall of the stainless mixer tank.

Agitation in the mixers is provided by 1 ft. 6 in. diameter "turbo-mixers" with V-belt drives. Two of the four mixers operate at 150 r.p.m., and two at 200 r.p.m. A decision as to which speed is the better has not been reached.

The air lifts for advancing the organic phase are constructed of PVC pipe and are set in each settler inside a plastics pipe "boot" into which the solvent overflows. The total height of organic in any settler can be raised or lowered easily by changing the position of this plastics boot. The aqueous phase flows from one settler into the succeeding mixer through a 6 in. diameter flexible Carlon hose.

Both aqueous and solvent flow are measured by recording Rotometers. A schematic diagram of two stages of this four-stage unit is shown in Fig. 2.

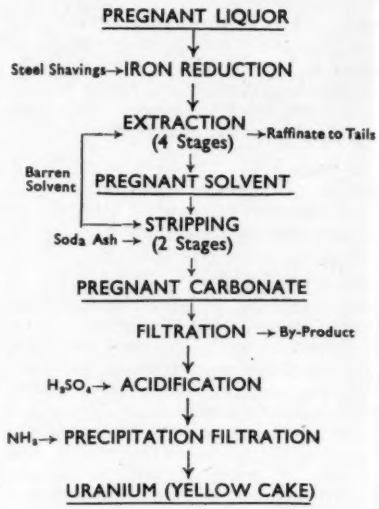


Fig. 1—Flow sheet for uranium solvent extraction process

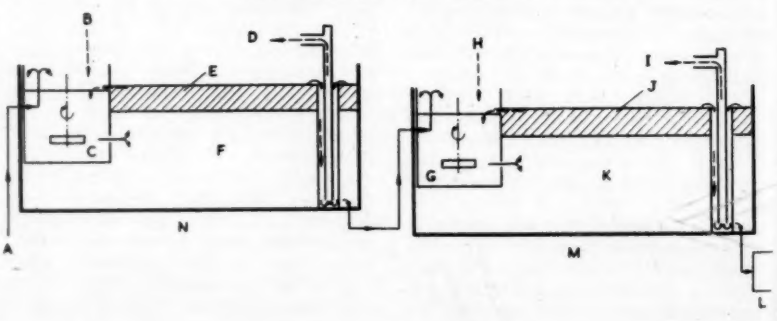
The stripping circuit is composed of a two-stage mixer-settler. In this case the mixers are outside the settlers and connected to them by piping. In this circuit the solvent flows by gravity, while the sodium carbonate stripping solution is advanced counter-current with air lifts. All equipment in this part of the plant is built of mild steel, since it has adequate corrosion resistance.

Mixers are the same size as those used in the extraction circuit; i.e., 4 ft. by 4 ft. equipped with 1 ft. 6 in. diameter turbo-mixers. Steam coils made of three turns of 2 in. pipe are welded in each mixer.

The settlers are 8 ft. diameter cone-bottom tanks with internal launders for solvent overflow. Cone-bottom settlers were used because of the presence of small amounts of precipitates of titanium and iron hydroxides, or their

Fig. 2—Diagram showing extraction circuit and mixer-settler arrangement

A—Aqueous (from mixer-settler I). B—From III. C—Mixer. D—To mixer I. E—Solvent. F—Aqueous G—Mixer. H—From IV. I—To mixer-II. J—Solvent. K—Aqueous. L—To mixer-settler IV. M—Mixer-settler III. N—Mixer-settler II



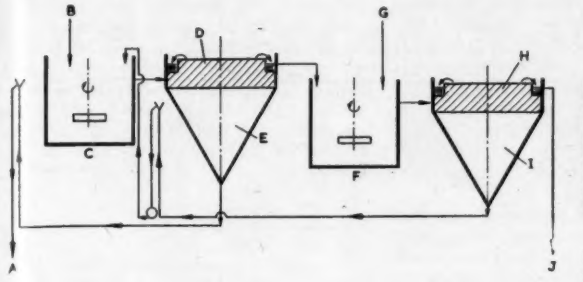


Fig. 3—Flow diagram of the stripping circuit

basic carbonates, which are formed during stripping.

In operation of the stripping unit the pregnant organic solvent from the first extraction unit settler is pumped by a centrifugal pump to mixer No. 1 where it is agitated with the advancing carbonate liquor. Solution from the mixer flows by gravity to settler No. 1 where the phases separate, the organic overflowing by gravity to mixer No. 2, while the carbonate liquor which contains some suspended solids flows via an underflow leg to a pump and storage tank.

This pregnant carbonate liquor is pumped through a plate and frame press to remove suspended solids, and the clear filtrate is sent to the uranium precipitation circuit.

The 10 per cent sodium carbonate solution is made up in a 5,000 gal. batch tank from which it flows by gravity through a recording Rotometer to the stripping circuit. A schematic flow diagram of the stripping circuit is shown in Fig. 3.

Precipitation

Uranium from pregnant carbonate solutions is recoverable by either of two general methods: (1) caustic precipitation or (2) destruction of carbonate with acid, followed by precipitation of uranium as yellow cake with ammonia or magnesia.

Caustic precipitation of uranium from carbonate strip liquors, followed by recycling of the carbonate, was used in some of the batch runs at Shiprock, but had no particular merit over the acid method in view of local plant conditions. Shiprock has an ion exchange plant which produces a uranium-bearing acid solution, and a solvent extraction plant which produces the sodium carbonate solution. It is obvious that some reagent economy can be effected by mixing these two streams and allowing them to neutralize each other, and then precipitating the uranium oxide product from this mixed solution. This is the practice which has been followed for several months past.

In some respects the complication in operating procedures introduced by mixing these two streams has perhaps out-weighed the reagent economy and this procedure is being reviewed at the present time with the intention of precipitating the ion exchange eluate and the strip carbonate liquors independently.

Operating Results

The operation of this plant has turned out to be very straightforward and simple. One operator per shift runs the extraction and stripping. A set of typical operating conditions are:

Aqueous flow	100 gm/min.
Solvent flow	20 gm/min.
Aqueous feed analysis—	
emf	300 mV.
*p*H	1·3
Temperature	90°F.
U_3O_8	1·4 gm/L.
V_3O_8	0·6 gm/L.
Sodium carbonate to strippers	2·5 gm/min.
Stripping temperature	110°F.

It has been possible to operate the solvent extraction unit for long periods with a tailing solution assay averaging less than 0·005 gm/L U_3O_8, corresponding to better than 99·7 per cent recovered. At a period of stable operations samples have been taken through the entire system and analysed for uranium content. A typical set of such analyses is given in Table I.

The consumption of reagents in this plant has been close to that predicted from laboratory work. It is as follows:

Iron for reduction	0·75 lb/lb. U_3O_8
Sodium carbonate	2·0 lb/lb. U_3O_8
Solvent loss	0·5 gal/1,000 gal. of aqueous treated
Sulphuric acid to destroy carbonate	1·6 lb/lb. U_3O_8
Ammonia for precipitation	0·15 lb/lb. U_3O_8

The amount of iron required for reduction is naturally a function of the properties of the leach solution—primarily the ferric iron content. This would be one of the major considerations in the choice of a solvent system since amine solvents are not so sensitive to the presence of ferric iron as the phosphates. At Shiprock, however, the steel shavings for reduction are delivered at a price of $22.00 per ton so the cost/lb. of product for this reduction step is low.

Soda ash consumption can be reduced to close to theoretical amounts but this will depend, to some extent, on the titanium content of the feed liquor and upon the care used in operating control.

Solvent losses given above were determined for the first 10,000,000 gal. of feed liquor treated in the plant. This loss is made up of two components. The first is the actual solubility of the solvent in the aqueous phase, and the second is the loss of organic carried out by the raffinate as small droplets. The solubility factor is rather small. Measurements of entrainment loss show that it accounts for at least half of the total solvent loss.

Undoubtedly a trap tank would prevent some of this entrainment loss. Another possibility would be to operate the mixers with the organic phase continuous by recycling solvent from the settlers back to the mixers. In experiments this has been found to decrease entrainment of solvent. Both alternatives, the trap tank and continuous organic phase in the mixers, are now under consideration for the Shiprock installation.

The costs given for sulphuric acid required to destory the carbonate and the ammonia required for precipitation of yellow cake allow for the amounts which would be required if the acid eluate from ion exchange were not mixed with the carbonate strip liquor.

The use of a high flash-point kerosene as a diluent has been of great aid in processing because of the decreased fire hazard. The material used at Shiprock is sold under the trade name "Napoleum 470," and is produced by the Deep Rock Oil Division of the company. It has a flash point of 160°F. compared with about 105°F. for the ordinary kerosenes available in the Shiprock area.

One of the questions always raised in the discussion of solvent extraction concerns emulsion formation. At Shiprock, the only problem of this sort has resulted from the graphite being introduced into the system by the dissolution of the steel shavings. There is no clarification filter on the feed liquor system and graphite freed from the iron is carried into the first stage extractor where it transfers into the organic layer in the No. 1 mixer. In the plant design, provision was made for removing this solid material by filtering the solvent at periodic intervals. However, it has never been necessary to use this solvent cleaning equipment because of an unforeseen but fortunate circumstance. The graphite-stabilized clods

TABLE I—TYPICAL SAMPLE ANALYSES

	Organic phase U_3O_8 gm/L	Aqueous phase U_3O_8 gm/L
Extractor		
No. 1	8·95	1·27
No. 2	7·92	·43
No. 3	2·29	·023
No. 4	·47	·002
Stripper		
No. 1	·37	55·6
No. 2	·010	2·6

of emulsion float to the surface of the solvent in the settler instead of remaining at the interface as had been anticipated. These clods pass over the organic overflow and into the sodium carbonate stripping circuit. In the first stripping mixer this graphite-stabilized emulsion is broken and the solvent is released while the solids drop out with the solid hydroxides and are removed in the by-product filter. In time this gummy material can cause trouble by plugging pipelines and pumps, but it is intended that a clarification filter will be installed on the feed liquor which will eliminate the trouble at the source.

Flow rates have been easy to maintain and control at any desired ratio. The control of interface levels has been no problem. The level of the aqueous phase in each settler is, of course, set by the height of the weir on the discharge pipe from that settler. Elevations of these weirs were set by calculation when the plant was designed and have not been altered.

The design of the settlers is such that if the organic should stop flowing for any reason, such as air lift failure, there is room for accumulation of the entire solvent excess in any one settling tank, so that it is impossible to spill solvent over the top of a settler.

In conclusion, it appears from the experience at Shiprock that the solvent extraction process on this type of feed liquor is exceedingly easy to operate, lends itself readily to continuous processing in inexpensive equipment, and is competitive in reagent cost with any other method of uranium recovery.

Reference

[1] Blake, C. A., Brown, K. B., Coleman, C. F., "The Extraction and Recovery of Uranium (and Vanadium) from Acid Liquors with Di (2-ethylhexyl) Phosphoric Acid and Some Other Organophosphorus Acids," ORNL-1903, 1955.

Men and Metals

Recent appointments made by The International Nickel Company Inc. include those of **Albert P. Gagnebin** and **L. E. Grubb** as assistant vice-presidents of the company. Mr. Gagnebin continues as manager of the nickel sales department, and Mr. Grubb, who has been general superintendent of the Huntington, West Virginia, works of the company since May, 1953, will be in charge of labour relations at all United States plants.

Appointed assistant vice-presidents of The International Nickel Company of Canada Limited are **Ralph H. Waddington, James C. Parlee, Richard A. Cabell** and **Paul Queneau.** Mr. Waddington has also been appointed general manager of the parent company's Ontario Division, and Mr. Parlee general manager of its Manitoba Division. Mr. Cabell and Mr. Queneau have also been appointed as vice-presidents of The International Nickel Company Inc., the U.S.A. subsidiary of the company.

Although he has retired from the board of Almin Limited and its associated companies, **Mr. Spence Sanders** is continuing with the group in the capacity of group consultant. Mr. Sanders has been a director since the formation of the company in 1945. **Mr. W. Brining,** A.C.A., has relinquished his appointment as secretary of Almin Limited, which he has held since 1945, and is succeeded as secretary by **Mr. A. E. Roe,** who has been assistant secretary of the company since 1952. Mr. Brining remains a director of Almin and its subsidiaries.

Appointed a director of Marchon Products and its associated companies, **Mr. P. Baines** will continue as secretary to the companies concerned.

New appointments made by The English Electric Company Limited are as follows:—**Mr. K. Druce,** D.F.H., A.M.I.E.E., to be manager of the Bristol office of the company in succession to **Mr. T. Robinson,** who retired at the end of last year; and **Mr. H. Granville - Brown,** A.I.E.E., to be manager of the Southampton office of the company in succession to **Mr. I. Mackintosh,** who also retired at the end of last year.

Appointed general manager, Naval Yard, Vickers - Armstrongs (Shipbuilders) Limited, **Mr. R. J. W. Rudkin,** B.Sc., M.I.N.A., joined the firm in 1941 and obtained his B.Sc., in naval architecture while gaining drawing office and shipyard experience at the Naval Yard. He was appointed assistant general manager of the Naval Yard in 1955.

Recent appointments made by the Davy and United Engineering Company Limited are **Mr. M. F. Dowding** to be chief engineer to the company in place of the late Mr. W. W. Franklin, who was technical director; and **Mr. A. A. Thomas,** who succeeds Mr. Dowding as engineering sales manager.

News from Expandite Limited is that two of the members of their staff are to pay visits to overseas countries this month. **Mr. A. J. Orbell** will be visiting Germany, where the company's activities have considerably increased during recent months, and **Mr. J. M. Robb** is to make a tour of Scandinavia.

Two new managers have been appointed by British Insulated Callender's Cables Limited. **Mr. A. F. Miller** is to be manager of the Aberdeen office and **Mr. L. R. Cleworth** is to be manager of the Newcastle branch office.

Aluminium-Tin Bearings

FOR some years the Tin Research Institute and the Glacier Metal Company have been working together on the practical development of a bearing alloy containing about 20 per cent tin, the remainder being aluminium hardened with from 1 to 3 per cent copper. The tin constituent has a structure which is reticular within the continuous aluminium matrix, that is to say, the tin has a structure which is itself continuous without disturbing the continuity of the aluminium. Should metal to metal contact occur between a shaft and a bearing with this reticular structure, there is an immediate supply of tin available at the surface to provide a thin soft layer of tin over the aluminium and thus inhibit surface breakdown.

This alloy, therefore, combines the strength of a continuous aluminium phase with the tin-availability of a comparatively heavy and continuous tin structure. When supplied in the form of steel-backed bearings, it provides a better balance between the opposing demands of high fatigue strength and low rates of wear than any other known plain bearing. Furthermore, unlike copper-lead bearings, it needs no lead-based overlay plating to keep shaft wear in check.

A significant feature for large diesel engine applications is that, since the alloy contains no free copper, there is no danger of copper penetration of steel journals.

Reticular aluminium-tin bearings can, of course, be supplied prefinished, but since they have no overlay plating, they can equally well be supplied semi-finished for boring in place, as is so often necessary or desirable in the case of large stationary diesel engines.

These bearings have already proved themselves in extensive road and test bed trials carried out over the past three years, and some half-million bearings made from the new material are already in actual use.

A final point of some importance is that, as compared with copper-lead plated types, steel-backed reticular aluminium-tin bearings are inherently somewhat cheaper to manufacture.

Industrial News *Home and Overseas*

Light Metals Available

A stock of 500 tons of light metals is a substantial quantity, but that is the amount which **The Atlantic Metal Co. Ltd.** is holding for disposal to the trade. These light metals are in sheets and extrusions of various sizes and shapes, and full details are given in the first of a series of announcements which appears on page 14 of the advertisement section of this issue of METAL INDUSTRY. The items detailed, however, do not include the whole of the stocks available and other details will be given in future announcements.

A T-Shaped Ingot

An interesting development by the technical staff of the **Aluminum Company of Canada** is the T-shaped ingot which has been made a standard product of the company. These ingots are so designed to fit on tines of a fork lift to be handled in stacks without strapping. This increases efficiency in handling, storing and melting. It is understood that these ingots are produced in 1,500 lb. and 750 lb. sizes.

A New Film

A 16 mm. sound film on the 6 cwt. capacity carbon-rod resistor furnace which is installed at the experimental foundry of the British Steel Castings Research Association, has been made by the association's own film unit. The film is available to non-members of the association on payment of a hire charge of five guineas.

Change of Address

It is announced that the London office of the Pulsometer group of companies is now at Pulsometer House, 20-26 Lamb's Conduit Street, W.C.1, with the telephone number of Holborn 1402.

Careers Booklet

A revised edition of the pamphlet on science in the "Careers for Men and Women" series has just been published for the Ministry of Labour and National Service. Separate sections of this revised pamphlet are devoted to physics, chemistry, biology, geology and metallurgy. Emphasis is on careers at a professional level, and a university degree course or preparation for the examination of one of the professional institutions is, therefore, recommended as the best training.

Precision Vacuum Oven

It has been announced by **Griffin and George Ltd.** that they are about to go into production with the "Gardiner Precision Vacuum Oven," which was developed in the research laboratories of Tate and Lyle during an exacting investigation of the difficulties of drying such labile products as sugar syrups and molasses containing fructose.

Its wider use is now envisaged wherever precise and reproducible results are required in determinations of loss of weight on heating. The term "loss of weight on heating" is used in preference to "moisture content." In this Gardiner oven, the sample is taken into solution and distributed over an aluminium powder extender contained in a sample dish. It is then heated under vacuum, while a current of air or inert gas, dried to a water content not exceeding 0·0007 mg/L, is bled over its surface.

The company believes that the use of this design of oven will introduce into "moisture" determinations a new order of precision, The first production batch is expected to be available for delivery in April-May this year.

New Offices

It is learned from **The English Electric Company Ltd.** that their Southampton office has moved to new premises at 29 Shirley Road with the telephone number of Southampton 28333-4.

Metal Finishing

A joint meeting of the Sheffield and N.E. Branch of the Institute of Metal Finishing with Leeds University, is to be held on Friday of next week (January 17) at the Grand Hotel, Sheffield, at 7 p.m., when a Paper will be presented by Mr. A. McL. Aitken on "Applications of Chemically Reduced Nickel Coatings."

A London Event

Members of the Corrosion Group of the **Society of Chemical Industry** are holding a Conversazione on Thursday, January 23, in the Battersea College of Technology, Battersea Park Road, London, S.W.11. Exhibits illustrating research and development, mainly in the field of protective coatings, are being arranged by a number of companies and research organizations. New information and ideas will be presented on many of them.

For the benefit of those unable to attend the Conversazione, the exhibition will remain open on Friday, January 24, from 9.30 a.m. to 3.30 p.m. No tickets or notification are required for this day.

End-Month Stocks

Tin stocks at the end of December last amounted to 12,202 tons, comprising Straits 3,835; English refined 6,487; Belgian 715; Dutch 955, and other standards tin 210 tons. They were 4,615 tons up on the month. Copper stocks totalled 20,279 tons, comprising London 11,046; Liverpool, 6,658; Birmingham, 1,700; Hull, 250; Manchester, 25; and Swansea, 600 tons. They were up 2,501 tons on the month.

Foundry Science Course

A syllabus of a new **Graduate Course in Foundry Science and Engineering** is introduced by the Department of Industrial Metallurgy, University of Birmingham. It is hoped to commence this course in October next. The course is a modification of the University's existing post-graduate course arranged specifically to help the foundry industry, and as such is somewhat of a new venture in this country.

The basic idea underlying the planning of this syllabus is that the course should provide post-graduate training in which the fields of foundry science and foundry technology are carefully balanced. Students will also have the advantage of close contact with research teams active in the field of melting and casting of metals.

The course assumes prior training in metallurgy, science or engineering up to degree standard. Depending on their prior qualifications, students will be admitted to a Diploma or to a M.Sc. degree course. The candidates for a M.Sc. degree must possess a first degree of the required standard. Lecture courses will be arranged to meet the requirements of those students taking the full one-year course. However, one or two brief lecture courses on selected topics will be arranged over short periods in such a way that they could be also attended by extra-mural students. In addition to the lectures given by the full-time University staff, some lectures will be given by leading authorities in research organization and in the foundry industry.

The subject matter of the lectures will be arranged in such a way as to outline the basic principles, but will deal mainly with advanced scientific knowledge and application. For the benefit of those candidates who have not had adequate training in metallurgy, arrangements could be made for them to take suitable additional courses during their post-graduate year. The full degree course has been planned to include 8 to 10 lectures per week, and the remaining time will be used for laboratory work, seminars, discussions and works visits.

Further information regarding this course and forms of application may be obtained from The Registrar, The University, Edgbaston, Birmingham. The inclusive fee for the course is £81. It is understood that in certain cases, where a student is not sponsored by an employer, the University will consider applications for remission of this fee and, where necessary, for the grant of a maintenance allowance during the period of attendance.

Restrictive Agreements

In the issue of the Board of Trade Journal for to-day (January 10), the Registrar of Restrictive Trading Agreements published the first of a quarterly series of additions and amendments to the alphabetical index of commodities about which there are agreements in the public register.

The indexes to the register, one alphabetical as published in the Journal and one in which the commodities are grouped by classes, may be inspected at the following addresses:—Office of the Registrar of Restrictive Trading Agreements, Chancery House, Chancery Lane, London, W.C.2; 9 Wemyss Place, Edinburgh, 3, or at Chichester House, 64 Chichester Street, Belfast.

Electrical Exhibition

Early information is given relating to the 1958 Electrical Engineers' Exhibition, which is to be held at Earls Court, London, from March 25 to 29. There will be some 400 exhibitors whose displays will cover an area of about 450,000 ft^2. Equipment covered in the exhibition will include both the industrial and domestic fields.

A Pensioners' Luncheon

On Saturday of last week some 780 guests attended the annual pensioners' luncheon which was given by the Metals Division of **Imperial Chemical Industries Ltd.** at Kynoch Works, Birmingham. The toast of "The Company" was proposed by

Mr. G. H. Taylor, aged 72, who had retired last September, and the reply was made by Mr. Maurice Cook, chairman of the Metals Division, who, in his remarks, said that continual improvements in manufacturing techniques in the quality of existing I.C.I. products would help to provide a fuller and richer life for men and women everywhere.

Members of the Kynoch Works Council and others of the staff acted as hosts for the occasion, and other speakers during the luncheon included Mr. M. J. S. Clapham, a joint managing director of the Metals Division, and Mr. C. R. Roughton, who, before his retirement, was chief wages officer. Presiding over the whole event was Mr. T. G. Austin, personnel director of the Division.

Extended Use

Their Mark 2A electronic Multelec recorder, developed for and previously reserved for sale to the atomic energy industries, has now been made generally available to all industries by **George Kent Ltd.** The applications of this instrument are as follows:—temperature measurement (thermocouple or resistance thermometer); direct millivoltage recording; for industrial measurements depending on a radioactive source and ionization gauge, such as of level, material thickness, density, etc., and for research work.

New Hose Coupling

Availability of a new hose coupling for use with low and medium pressure compressed air and fluids is announced by **Airtech Limited.** Developed after many years' experience of the use of compressed air in coal mining and mechanical engineering, thousands of these couplings are said to be in use in many industries.

The manufacturers state that such couplings should be of great interest to all makers and users of pneumatic tools, and to users of compressed air, water and other liquids in such industries as building and civil engineering, general factory installations, chemical, marine engineering, and foundries and blast furnaces.

Precious Metals

At Regent House, St. Philip's Place, Birmingham, this evening, the Midland Section of the **Society of Instrument Technology** will hold a meeting at 7 p.m., at which Mr. J. G. Want will give an address on "The Engineering Applications of the Precious Metals."

Official Stockholders

It has been announced that **Henry Righton and Company Ltd.** have been appointed official stockholders of non-ferrous metals for Imperial Chemical Industries Limited, Metals Division, and henceforth all materials supplied by them will be exclusively of I.C.I. manufacture.

The new premises of Henry Righton and Co., in Pentonville Road, London, N.1, have been specially designed for the storage and rapid handling of metals and, being carefully temperature-controlled, enable materials to be maintained in mill condition. A comprehensive stock and weights booklet, giving detailed information of the range available, may be obtained from the company on request.

Bronze and Brass Founders

A meeting of members in the Yorkshire area of **The Association of Bronze and Brass Founders** is to be held on Thursday, January 23 next, at the Great Northern Hotel, Leeds, at 12.15 p.m. At this meeting, Mr. E. C. Mantle, of the British Non-Ferrous Metals Research Association, will be present to speak and answer questions on the "Survey of Furnaces for Melting Copper Alloys with Cost Data Compiled under Production Conditions in Sand Foundries."

New Representatives

Recent news from **Armstrong Whitworth (Metal Industries) Ltd.** is to the effect that Mr. David John Guild has recently joined the staff of that company, and also that of Jarrow Metal Industries Ltd., as technical representative, and has been appointed to their Midlands area. He will assist the companies' Midlands manager, Mr. J. Bell, and will operate from their offices at Somerset House, Temple Street, Birmingham, 2.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 13,201 tons, comprising London 4,466, Liverpool 7,950, and Hull 785 tons. Copper stocks totalled 20,054 tons, and comprised London 11,046, Liverpool 6,458, Birmingham 1,700, Manchester 25, Swansea 575, and Hull 250 tons.

Bolivia Cuts Production

As part of the Bolivian Government's plan to reduce the high cost of mineral production and to cover costs, the Bolivian Mining Corporation is to close down the Bolsanegra Mine, which is said to be uneconomic. It has also been announced that the Kami Mine will in future produce tin only and cut out wolfram production. It is believed that though these measures will cause labour troubles, they will benefit the country's economy under the stabilization plan, according to trade sources.

Meanwhile, the United States firm National Lead, has approached Bolivia for permission to exploit the Matilde Mine, which formerly belonged to the Hochschild enterprise.

Scrap Metal Lectures

Those readers who are interested in the non-ferrous scrap metal industry are reminded that, on Thursday evening next, January 16, the first of a course of ten lectures on the subject of "Virgin and Scrap Non-Ferrous Metals" will be given at the City of London College. This course has been arranged by the National Association of Non-Ferrous Scrap Metal Merchants and will be held at the College on Thursdays from 6 to 7.30 p.m.

In addition to the various lectures, films and demonstrations will be given during the course. The fee for the course is £1 15s. 0d. and full details of the programme, with application forms, may be obtained from the secretary to the association at Africa House, Kingsway, London, W.C.2.

At the Boat Show

With a larger number of exhibits than in previous years, the fourth **National Boat Show** has again attracted widespread interest during the past two weeks in London. Aluminium once more occupies a prominent position among the non-ferrous metals being used in the construction and fitting out of small craft, and a number of launches of light alloy construction are on show. In this field, the stand of Birmabright Ltd. is of particular note. The application to boat building of epoxy resin adhesives for bonding metals is emphasized by Aero Research Ltd., and, in the finishing field, Celion Ltd. are showing their self-etch primer for light metals.

The tremendous number of castings in brass, gunmetal and phosphor bronze which are on show indicates the very wide usage of these metals in marine fittings, and the interest in small boat sailing which has sprung up in the post-war years has done much to stimulate demand for the smaller fittings of this type. Pressure die-castings in aluminium alloy have invaded this field and the Holt-Allen fittings shown are of particular interest to small boat sailors who have to work to a tight budget.

A Birmingham Luncheon

On Tuesday last at the Queen's Hotel, Birmingham, members of **The Non-Ferrous Club** met for their first monthly luncheon of the New Year. The guest speaker on this occasion was Mr. Arnold Gourevitch, honorary surgeon at the Queen Elizabeth Hospital, Birmingham, and several other Midland hospitals. In the course of his address, the speaker dealt with a genuine Birmingham character of some 50 years ago—Professor George Jordan Lloyd—one of the outstanding surgical men of his time.

At this luncheon meeting a collection was taken on behalf of the Commonwealth Fund for the Blind and realized £14 16s. 0d. The next meeting of the Club will be held on February 5, when the guest speaker will be Mr. Norman Harper.

A Nuclear Energy Congress

Advance information has been given of the 1958 Nuclear Congress which is to be held at the International Amphitheatre, Chicago, U.S.A., from March 17 to 21 this year. Over 30 sponsoring organizations are concerned in this Congress, which will include the Fourth Nuclear Engineering and Science Conference; the atomic exposition "Atomfair"; the sixth Hot Laboratories and Equipment Conference; the Atomic Energy Management Conference, and the American Power Conference. Full details of the programme for this event may be obtained from the offices of the Congress at 25 West 45th Street, New York 36, N.Y.

Appointments

It is announced by the Lead Development Association that **Mr. A. R. Mathias** has been appointed chairman of the association for the current year in succession to **Mr. H. L. Evans,** who had held this office since January, 1956. It is also announced that **Lt.-Col. W. E. Grey** has been re-appointed chairman of the Lead Sheet and Pipe section of the association.

Trade Enquiries

From the British Embassy at Havana, Cuba, comes the information that Sr. Luis Crucet Valera, of P.O. Box 894, Havana, wishes to get in touch with United Kingdom suppliers of litharge, red lead, lead sheets and ingots, copper backing varnish for mirrors and ferric oxide. The Board of Trade (Export Services Department) states that Sr. Valera has been engaged in the commission agency business for about 30 years. Suppliers interested in this enquiry are

invited to write direct to the Cuban enquirer.

Another enquiry comes from the Schofield Hardware Co. Inc., of Florence, South Carolina, U.S.A., who have advised the British Consulate at Atlanta that they are interested in purchasing from a United Kingdom source, 10,000 lb.—36 in. by 96 in.—16 oz. cold rolled sheet copper packed in cases of approximately 500 lb., with size, thickness and weight contents marked on each box. This company carries on a jobbing business of hardware and electrical supplies, and manufacturers interested in the enquiry are advised to contact the U.S. concern direct.

Cutting Copper Imports

It is reported from Washington that Representative John B. Bennett proposes to introduce a Bill into Congress designed sharply to reduce copper imports. The measure would have the effect of establishing a steeper tariff duty on copper imports and protecting the domestic industry, he indicated.

Under present law, an import tax of two cents per lb. is levied when copper reaches a price of 24 cents per lb., the so-called "peril point." The Representative said that was not sufficient to protect U.S. mines. "In the light of present conditions, a peril point of 30 cents is necessary," he said. His Bill would also increase the tax from two cents to four cents per lb.

A New Principal

It has been announced that **Mr. J. A. C. Williams,** M.Sc., A.M.I.Mech.E., A.F.R.Ae.S., has been appointed Principal of the College of Aeronautical and Automobile Engineering, Chelsea, London. Formerly head of the engineering section of the National Coal Board's Industrial Training Branch, Mr. Williams has been concerned with technological education since 1939, when he became a lecturer in aerodynamics at the de Havilland Technical School. During the war he was on the initial design team of the Mosquito fighter-bomber and also worked with the Airscrew and Jicwood companies. Previous appointments held by Mr. Williams include those of senior lecturer in the Department of Engineering Production and Management at Wolverhampton Technical College, and a research fellowship at the College of Aeronautics, Cranfield.

Chilean Copper Refineries

Three new copper refineries are to be built this year in Chile, to cover the needs of the small and medium miners. The present refinery at Paipote, working at capacity, does not cover the entire needs of the small miners. In 1957 it treated an average of 11,500 tons of ore per month and produced an average of 1,300 tons of blister copper monthly.

Caja de Credito Minero and its branch, Empresa Nacional de Fundiciones, decided early in 1957 to build a new refinery for the central part of Chile (Paipote is in the north). After prolonged argument, where many influences were felt, a decision has been taken to build the new refinery at Ventana de Quintero, on the Pacific coast and some 140 kilometres from Santiago. It is felt that the new copper refinery (which at first will produce only blister, but eventually will be converted to the electrolytic process) will aid the development of new ore fields in this region.

At the same time, Caja de Credito Minero (Mining Credit Authority) and Empresa Nacional de Fundiciones have approved the conversion of the cement plant at Juan Soldado, recently closed because of lack of markets, to copper refining, and the construction of a third refinery at Ovalle, midway between Santiago and Paipote.

Malayan Tin Industry

Reports from Kuala Lumpur state that the Malayan Mining Employees' Union is to ask the Government to investigate dimissals of staff by tin mining companies to see whether there have been any "unjustifiable and arbitrary" dismissals. The companies are reducing staff because their output has been restricted under the International Tin Agreement. The Government has appointed a Working Committee to investigate unemployment in the tin mines. The Union's appeal is contained in a memorandum to the committee.

Trade with Canada

A new edition of the pamphlet "Setting Up a Subsidiary in Canada" has just been published. The booklet makes no claim to be more than an introduction to the subject, but it touches on most of the more important factors which have to be taken into account, such as: application to the Bank of England and Treasury; the difference between Dominion and Provincial registration; solicitors' fees and fees for incorporation; selection of a name; Federal, Provincial and other taxation; and industrial relations and labour legislation. It includes an appendix listing useful contacts in Canada.

The pamphlet will be sent free on request. Applications should be addressed to Directories and Notices Section, Board of Trade, Room 8147, Horse Guards Avenue, London, S.W.1.

Anglo-Polish Quotas

Negotiations between representatives of the Government of Poland and the Government of the United Kingdom have resulted in the drawing up of quota lists covering United Kingdom exports to Poland and Polish exports to the United Kingdom during 1958 under the three-year Trade Arrangement signed on December 31, 1956.

These provide greater scope for United Kingdom exports during 1958 of goods such as machinery, machine tools, instruments, consumer goods, etc. The new quota lists also provide for the export of Polish goods such as canned meat, other foodstuffs, chemicals, etc., at a somewhat higher level than in 1957.

Induction Heating

A new induction heating coil of special design is now being used for the manufacture of Saffire hand welding and cutting blowpipes by **British Oxygen Gases Limited (Equipment Division).** The brazing assembly consists of three stainless steel tubes connected to an angle nozzle head, together with hard brazing rings. Using the orthodox method of brazing, the assembly was fixed in position on a "rise and fall table," which was raised to allow the tubes to pass through a closed coil until the assembly reached the brazing position. After the components had been subjected to a rapid air quench, the table was lowered so that the assembly could be removed. During the period when the table was in operation, the induction heating machine lay idle. It was decided that production could be increased if a new type of coil was designed which would eliminate the need for the table to be used.

A new coil was constructed in three parts. Two water-cooled forks were made to fit the contour of the component, with a slight taper at the front of each member. These were attached to a fixture of insulating material and mounted on a fixed pedestal. A wedge piece with a taper corresponding to the taper on the forks was then attached to the work-holding fixtures. This was made to slide horizontally in runners on the fixture holding the coil, the wedge piece completing the circuit. A micro switch was attached to a runner on the coil-holding fixture to ensure that the current could not be switched on until the work was in position, thus preventing arcing. The three tubes, angle head and brazing rings are slid into the new split coil and the induction heating machine completes its brazing cycle immediately.

This new coil and fixture has enabled the advantages of the induction method of brazing to be fully utilized. While the brazing operation is being carried out, an additional work-holding fixture can be loaded, thus ensuring maximum machine utilization and increased productivity.

A Technical Publication

A useful loose-leaf brochure, distributed by **English Electric Valve Co. Ltd.** is intended to give the essential information on valves recommended for R.F. heating service, including both mercury vapour and Xenon rectifiers. Special attention has been paid to the use of constant current curves, which are given for all oscillator types, in addition to the conventional curves, together with the time-saving transparent E.E.V. calculator. This latter is supplied as part of the brochure but is intended to be removed for use on the constant current curves. In order to further facilitate the use of this calculator, a number of design sheets are also included. In addition to the charts, there are also many diagrams and photographs which give an added value to the brochure.

Forthcoming Meetings

January 14—Institute of Metals. South Wales Local Section. Department of Metallurgy, University College, Singleton Park, Swansea. "Electron Microscopy." J. W. Menter. 6.30 p.m.

January 14 — Institution of Production Engineers. Birmingham Graduate Section. The James Watt Memorial Institute, Great Charles Street, Birmingham, 3. "Component Production from Metal Powder." G. R. Bell. 7 p.m.

January 15 — Society of Chemical Industry. Corrosion Group. Society of Chemical Industry, 14 Belgrave Square, London, S.W.1. "Stress Corrosion Cracking." T. P. Hoar and J. G. Hines. 6.30 p.m.

January 15 — Institution of Production Engineers. Birmingham Section. The James Watt Memorial Institute, Great Charles Street, Birmingham, 3. "Inter-Process Mechanisms for Press Work." J. P. Udall. 7 p.m.

January 17—Institute of Metal Finishing. Sheffield and North East Branch. Grand Hotel, Fitzwilliam Room, Sheffield. "Applications of Chemically Reduced Nickel Coatings." A. McL. Aitken. 7 p.m.

Metal Market News

NOT unnaturally, business has been quiet and it is hardly to be expected that much activity will develop before the second half of the month at the earliest. A feature of the situation has been the strength of the £ against the dollar, but it cannot be said that there is much evidence of optimism for most people view the outlook with a good deal of misgiving. Certainly the position in the States is not very promising, although Wall Street staged some good sessions over the turn of the year. On the Metal Exchange the markets lost ground on balance but losses were not serious, although lead showed a much easier tendency. In regard to these two metals, viz. lead and zinc, there cannot be any doubt that the position in the United States is most unsatisfactory and, in view of the influence which the economic situation in the U.S. exercises on other countries, it is evident that a decline in activity across the Atlantic must be reflected here, and, indeed, at other centres also. Sectionally, there seems to be a certain amount of uneasiness about the outlook for tin and, in consequence, the three months' price has been somewhat depressed. It can hardly be disputed that the Tin Pool is finding itself in the position of having to take up very large quantities of the metal, and at a very rapid rate, more rapid, in fact, than had been anticipated. So far consumers have not broken cover, and this must be disappointing to the Tin Council. Uneasiness is in the air and the fact is there are again fears that the situation may turn sour, in consequence of which there could be a risk of the present arrangement breaking down. Obviously, much depends on events during the next few weeks, but it must be expected that this will be rather an anxious time and operators are likely to proceed with the utmost caution.

The Metal Exchange was closed on New Year's Day in accordance with the usual custom and turnovers were, therefore, below average, the copper figure being about 5,000 tons. Minor fluctuations occurred, but on balance cash was 25s. lower and three months 30s. down. On Christmas Eve the market had been mildly cheered by the news that the Board of Trade had again postponed the disposal of 27,000 tons of copper, although this action was expected. On the other hand, there has been a reduction in the Belgium price and rumours were in circulation that a cut by the custom smelters was by no means impossible. Indeed, it is surprising that this has not been done already, for demand is apparently poor and the 25½ cents level is certainly undercut. An increase of 401 tons in L.M.E. stocks ushered in the New Year, making the total 20,304 tons so that, as was suggested in certain quarters some time ago, the 20,000 tons level has been reached and passed. Nor is there any reason to suppose that we have necessarily reached the top of this reserve of copper, and some people believe that we may reach 25,000 tons. Rather surprisingly, the contango has lately shown a tendency to contract, and at the close of last week's trading stood at £3 5s. 0d.

On the tin market last week the turnover was just in excess of 600 tons, much of the buying being doubtless on account of the Tin Council. On balance, cash lost 10s. to close at £730 10s. 0d., while the three months' price was £4 10s. 0d. down at £728, a backwardation of £2 10s. 0d., therefore, being established. There was a further increase in L.M.E. stocks of 570 tons to 12,182 tons. Both lead and zinc again lost ground, the former closing £1 12s. 6d. lower at £71 15s. 0d. for both January and April. Zinc presented a steadier appearance but was, nevertheless, 7s. 6d. down for prompt and 10s. lower for April, at £61 7s. 6d. and £61 10s. 0d. respectively. As we write, two queries are posed before the market, viz. if and when the price of zinc will break £60 and when will cash copper be below £180 again?

Birmingham

The announcement of the substantial cuts in imports of manufactured goods to New Zealand has come as a blow to manufacturers in the Midland area. Many of them are involved in the New Zealand trade, not least among them the motor car manufacturers, who regard that country as their principal market. They, naturally, hope that the cuts will be short-lived. On the other hand, with a very substantial market in North America and Canada, short-time working is unlikely. Other trades, such as electric motors, are also affected. Apart from this development, trade in the area is maintained and the outlook for the next few months is satisfactory.

The strength of the iron and steel industry is due mainly to the activity in the motor trade, with its big demand for sheets, and the busy engineering works throughout the Midland towns. The railway modernization programme has brought another large contract to a Midland firm of rolling stock builders which will supply diesel locomotives and coaches. The steel re-rolling mills are still under-employed, due to some quietness in trade in sections. Foundries are busy supplying castings for the engineering industries, but there is a lull in the market for light castings. There is still a strong demand for structural steel.

New York

Non-ferrous metals were quiet during the past week, with activity negligible, reflecting holiday and near-end considerations. The metals were steady in price, except for some softness in tin. In copper, custom smelters sold a small quantity of electrolytic at 25½ cents per lb., while producers sold a negligible amount of copper at 27 cents per lb. Brass mills were reported looking to 1958 with little hope of any immediate improvement in business.

Industry officials expect brass mill activity in 1958 as a whole to average below the 1957 rate, which was noticeably under 1956 operations. First quarter, and possibly first half 1958 operations, they said, would plod along at about the same reduced pace as for the past several months. But all hopefully agreed that inventories of their customers have been reduced sharply. One leading brass mill official said that he guessed that operations of the mills in 1958 would be about five to ten per cent under the 1957 rate. Most brass mill officials said that December activity was lower than November, and that first half 1958 operations were going to be slow. Trade sources, noting that fabricator figures for November were not encouraging, said that December statistics were expected to be lower.

Lead and zinc activity was meagre, attention was attractive to the forthcoming Tariff Commission recommendations.

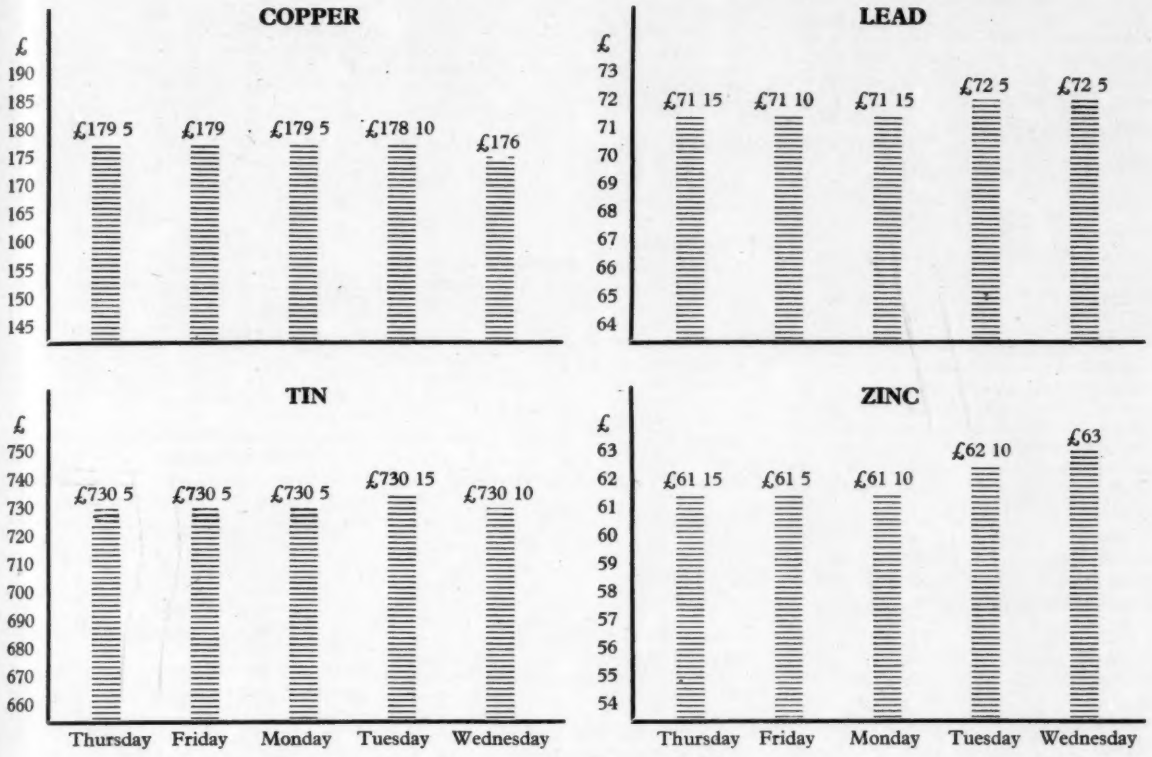
Tin was softer, reflecting the decline abroad and lack of buying interest here. Traders said the recessive conditions in the U.S. economy, including steel operations, and the possibility of a breakdown of the export agreement among countries facing unemployment because of the quotas, induced a lower market.

Canada

It has been announced in London that a drilling campaign has been initiated on the property of Cordoba Mines Limited, in Canada, following a survey report indicating gold and copper deposits of the "greatest importance." Cordoba's field geologist has reported that a strictly representative pattern sampling over a width of 5 ft. to 6 ft. on the extension of Trench 1 has given assays running as high as 1·05 ounces per ton gold—36·75 dollars per ton plus 0·94 per cent copper, indicating beyond doubt that the area was of the greatest importance. Surface values of this order had seldom if ever been obtained from any of the producing mines in the district—none of which had any appreciable copper.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 2 January 1958 to Wednesday 8 January 1958



OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	Canada c/lb ≏ £/ton	France fr/kg ≏ £/ton	Italy lire/kg ≏ £/ton	Switzerland fr/kg ≏ £/ton	United States c/lb ≏ £/ton
Aluminium		25.63 203 10	198 172 5 0	400 232 0	2.50 209 0	28.10 224 17 6
Antimony 99.0			195 169 12 6	440 255 5		33.00 264 0
Cadmium			1,400 1,218 0	2,800 1,624 0		155.00 1,240 0
Copper						
Crude						
Wire bars 99.9				370 214 12 6		
Electrolytic	25.25 184 10	26.50 218 17 6	230 200 2 6		2.25 188 2 6	27.00 216 0
Lead		12.25 101 2 6	123 107 0	185 107 7 6	.92 77 0	13.00 104 0
Magnesium						
Nickel		71.50 590 10	1,060 922 5	1,330 771 10 0	8.10 677 2 6	74.00 592 0
Tin	101.00 738 7 6		884 769 0	1,400 812 0	9.00 752 6	92.12 737 0
Zinc						
Prime western		10.00 82 12 6				10.00 80 0
High grade 99.95		10.60 87 10 0				
High grade 99.99		11.00 90 5				
Thermic			107.12 93 2 6			
Electrolytic			115.12 100 2 6	157 91 0	.87 72 15	11.75 94 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 8/1/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	197	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		10	0
Calcium	„	2	0	0
Cerium 99%	„	13	18	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite	per unit		—	
Copper H.C. Electro	ton	176	0	0
Fire Refined 99·70%	„	175	0	0
Fire Refined 99·50%	„	174	0	0
Copper Sulphate	„	71	0	0
Germanium	grm.		3	4
Gold	oz.	12	9	0½
Indium	„		10	0
Iridium	„	27	0	0
Lanthanum	grm.		15	0
Lead English	ton	72	5	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	300	0	0
Mercury	flask	69	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	7	10	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	16	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	5½
Tellurium	lb.		15	0
Tin	ton	730	10	0
Titanium	lb.		19	6
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	62	12	6
Dust 95/97%	„	104	0	0
Dust 98/99%	„	110	0	0
Granulated 99+%	„	87	12	6
Granulated 99·99+%	„	103	16	3

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

†**Aluminium Alloy**		£	s.	d.
B.S. 1490 L.M.1	ton	154	10	0
B.S. 1490 L.M.2	„	158	10	0
B.S. 1490 L.M.4	„	182	0	0
B.S. 1490 L.M.6	„	204	10	0

†Average selling prices for November.

***Aluminium Bronze**				
BSS 1400 AB.1	ton		—	
BSS 1400 AB.2	„		—	
***Brass**				
BSS 1400-B3 65/35	„	135	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„		—	
***Gunmetal**				
R.C.H. 3/4%	ton		—	
(85/5/5/5)	„	166	0	0
(86/7/5/2)	„	178	0	0
(88/10/2/1)	„	222	0	0
(88/10/2/½)	„	233	0	0
Manganese Bronze				
BSS 1400 HTB1	„	181	0	0
BSS 1400 HTB2	„		—	
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„		—	
Phosphor Copper				
10%	„	218	0	0
15%	„	225	0	0

**Average prices for the last week-end.*

Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	345	6	0
Grade D Plumbers	„	279	9	0
Grade M	„	378	6	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	97	1	3
Mazak V	„	101	1	3
Kayem	„	107	1	3
Kayem II	„	113	1	3
Sodium-Zinc	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			£	s.	d.
Sheet 10	S.W.G.	lb.		2	9
Sheet 18	S.W.G.	„		2	11
Sheet 24	S.W.G.	„		3	2
Strip 10	S.W.G.	„		2	9
Strip 18	S.W.G.	„		2	10
Strip 24	S.W.G.	„		2	11½
Circles 22	S.W.G.	„		3	3
Circles 18	S.W.G.	„		3	2
Circles 12	S.W.G.	„		3	1
Plate as rolled		„		2	8½
Sections		„		3	2½
Wire 10	S.W.G.	„		3	0
Tubes 1 in. o.d. 16 S.W.G.		„		4	1
Aluminium Alloys					
BS1470. HS10W.					
Sheet 10	S.W.G.	„		3	1½
Sheet 18	S.W.G.	„		3	4
Sheet 24	S.W.G.	„		3	11½
Strip 10	S.W.G.	„		3	1½
Strip 18	S.W.G.	„		3	3
Strip 24	S.W.G.	„		3	11
BS1477 HP30M.					
Plate as rolled				2	11½

Aluminium Alloys—*cont.*			£	s.	d.
BS1470. HC15WP.					
Sheet 10	S.W.G.	lb.		3	9½
Sheet 18	S.W.G.	„		4	1½
Sheet 24	S.W.G.	„		4	11½
Strip 10	S.W.G.	„		3	10½
Strip 18	S.W.G.	„		4	1½
Strip 24	S.W.G.	„		4	9
BS1477. HPC15WP.					
Plate heat treated		„		3	6½
BS1475. HG10W.					
Wire 10	S.W.G.	„		3	10½
BS1471. HT10WP					
Tubes 1 in. o.d. 16 S.W.G.		„		5	0
BS1476. HE10WP.					
Sections		„		3	2
Beryllium Copper					
Strip		„	1	4	11
Rod		„	1	1	6
Wire		„	1	4	9
Brass Tubes		„		1	5½
Brazed Tubes		„		—	
Drawn Strip Sections		„		—	
Sheet		ton		—	
Strip		„	209	5	0
Extruded Bar		lb.		1	8½
Extruded Bar (Pure Metal Basis)		„		—	
Condenser Plate (Yellow Metal)		ton	147	0	0
Condenser Plate (Naval Brass)		„	158	0	0
Wire		lb.		2	3
Bronze Sheet and Strip		ton		—	
Copper Tubes		lb.		1	8½
Sheet		ton	205	10	0
Strip		„	205	10	0
Plain Plates		„		—	
Locomotive Rods		„		—	
H.C. Wire		„	227	15	0
Cupro Nickel					
Tubes 70/30		lb.		3	2½
Lead Pipes (London)		ton	115	5	0
Sheets (London)		„	113	0	0
Tellurium Lead		„	£6 extra		
Nickel Silver					
Rods		lb.		—	
Sheet and Strip 7%		„		3	3½
Wire 10%		„		3	10
Phosphor Bronze					
Wire		„		3	6½
Titanium					
Billet		lb.	4	10	0
Sheet		„	6	12	0
Wire		„	9	10	0
Tube		„	16	0	0
Zinc Sheets, English destinations		ton	97	0	0
Strip		„		nom.	

LATE NEWS

London.—The undertone of the manganese ore shipment market continues unsettled, trade quarters say. For good grade 46-48 per cent material, a range of from 108d. to 113d. per long ton unit c.i.f. Europe is now indicated, compared with 109d. to 117d. recently.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 7/1/58.

	£
Aluminium	
New Cuttings	158
Old Rolled	130
Segregated Turnings	95
Brass	
Cuttings	125
Rod Ends	112
Heavy Yellow	93
Light	88
Rolled	115
Collected Scrap	90
Turnings	107
Copper	
Wire	157
Firebox, cut up	157
Heavy	150
Light	145
Cuttings	157
Turnings	141
Braziery	125
Gunmetal	
Gear Wheels	157
Admiralty	157
Commercial	128
Turnings	123
Lead	
Scrap	64
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	128
Turnings	123
Zinc	
Remelted	53
Cuttings	44
Old Zinc	29

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton.) :—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£156.12.6)	180
Heavy copper	(£152.5.0)	175
Light copper	(£130.10.0)	150
Heavy brass	(£95.15.0)	110
Light brass	(£78.7.6)	90
Soft lead scrap	(£56.10.0)	65
Zinc scrap	(£34.17.6)	40
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£213.2.6)	245
Heavy brass	(£187.0.0)	215
Light brass	(£161.0.0)	185
Zinc castings	(£67.17.6)	78
Tin	(£565.10.0)	650
Aluminium pans (98½ per cent)	(£139.5.0)	160
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£104.10.0)	180
Lead, soft, first quality	(£88.15.0)	153
Lead, battery plates	(£55.2.6)	95
Copper, first grade	(£174.0.0)	300
Copper, second grade	(£159.10.0)	275
Bronze, first quality machinery	(£179.17.6)	310
Bronze, commercial gunmetal	(£150.17.6)	260
Brass, heavy	(£119.0.0)	205
Brass, light	(£110.5.0)	190
Brass, bar turnings	(£124.15.0)	215
New zinc sheet clippings	(£58.0.0)	100
Old zinc	(£43.10.0)	75

Financial News

Westinghouse Brake

For the year to September 30 last, the Westinghouse Brake and Signal Company Ltd. is declaring a dividend of 10 per cent, an increase of 1 per cent on the previous year. Group trading profit is shown at £2,143,466. Taxation takes £1,049,340; to general reserve £36,207, and taken forward £374,493.

Wright, Bindley and Gell

In spite of lower profit margins and a sharp fall in metal profits, group net profits for the year ended September 28 last are shown at £44,156. Dividend recommended is 20 per cent.

I.C.I. and Yorkshire Copper

Negotiations between Imperial Chemical Industries Limited and The Yorkshire Copper Works Limited have now reached a stage where the latter company is in a position to submit the merger proposals to its shareholders for approval. This will be done at an extraordinary general meeting of the Yorkshire company, to be held at the Queens Hotel, Leeds, on Monday, January 27 next.

A new company, to be called Yorkshire Imperial Metals Limited, is to be formed to which the undertaking and business of the Yorkshire Copper Works will be transferred and to which I.C.I. will transfer that part of the undertaking carried on by its Metals Division which consists of the production, sale and distribution of copper and copper alloy tubes, ferrules, plates and tube fittings, and lead and lead alloy sheet and pipe, and zinc chloride. The share and loan capital of the new company will be owned as to 50 per cent by the Yorkshire company and as to 50 per cent by I.C.I. It is proposed that the Yorkshire Copper Works should change its name to "The Yorkshire Copper Works (Holdings) Limited."

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons, Limited, Company Registration Agents, Chancery Lane, W.C.2.

Metals and Ropes Company Limited (594153), Finsbury Court, Finsbury Pavement, E.C.2. Registered November 22, 1957. To take over business of importers and exporters carried on at 46 Seymour Street, W.1, by Metals and Ropes Company, and to carry on business of importers and exporters of metals, ropes, etc. Nominal capital, £1,000 in £1 shares. Directors: A. Argy, Annie Argy and F. Argy.

R. E. Goodlad Limited (594156), Broad Street Chambers, Broad Street, Sheffield, 2. Registered November 22, 1957. To carry on business of iron and steel merchants, general metal and scrap merchants, etc. Nominal capital, £3,000 in £1 shares. Directors: R. E. Goodlad and Mrs. M. R. Goodlad.

R. E. Bristow Limited (594221), 64-5 St. Marys Butts, Reading. Registered November 25, 1957. To carry on business of dealers and merchants and workers in metals and minerals, etc. Nominal capital, £1,000 in £1 shares. Directors: R. E. Bristow and K. E. Bristow.

Vodos Limited (594226), Factory Street, Banbury, Oxon. Registered November 25, 1957. To carry on business of manufacturers of metal, plastics, concrete, glass, fibreglass and timber, etc. Nominal capital, £100 in £1 shares. Directors: D. J. Stanton and Mrs. V. M. Stanton.

J. E. C. Powell Limited (594496). Registered November 28, 1957. To take over business of agricultural engineers and iron and brass founders carried on as J. E. C. Powell and Company at Brancaster, Norfolk, etc. Nominal capital, £100 in £1 shares. Directors: F. N. Turner and P. N. Turner.

Trade Publications

Impact Extrusions. — Imperial Chemical Industries Ltd., Metals Division, P.O. Box 216, Birmingham, 6.

Within the space of some eight pages, a brochure illustrates some designs which can be produced by means of impact extrusion. These illustrations are accompanied by instructive captions and other useful notes.

Oiling the Wheels.—Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2.

Oiling the wheels of industry would scarcely seem to be a matter for comedy, but in the hands of artist Peter Kneebone it can be hilariously funny. For some time past, Shell-Mex and B.P. Ltd. have been publishing a series of advertisements by this artist featuring leading British industries. The series has been so successful that the company decided to collect the complete series into a brochure of 28 pages bound in a stiff cover. Among the subjects dealt with are tube working, open-cast mining, car manufacture, aircraft manufacture, and automation in industry. The illustrations are in full colours and each subject serves to remind the reader that there is a specialized grade of Sea Shell lubricant for every modern industrial process.

Ciment Fondu. — Lafarge Aluminous Cement Co. Ltd., 73 Brook Street, London, W.1.

This is a new publication from this company, covering 32 pages, and is especially designed for the maintenance engineer. It shows how Ciment Fondu makes all the following four concretes: concrete in hours, not days; corrosion-resistant concrete; refractory concrete (with refractory aggregates) up to 1,350°C.; and insulating concrete (with insulating aggregates) up to 1 000°C. Copies of this brochure may be obtained by interested readers on application to the company.

THE STOCK EXCHANGE

Undertone Generally Very Steady And Slight Improvement In Activity

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 7 JANUARY +RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1957 HIGH	1957 LOW	1956 HIGH	1956 LOW
£	£			Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	19/6 +3d.	10	10	10 5 3	28/3	18/–	25/–	20/–
400,000	2/–	Anti-Attrition Metal	1/3 —3d.	8¼	7½	13 12 0	2/6	1/6	2/2½	1/6½
33,639,483	Stk. (£1)	Associated Electrical Industries ...	48/6 +3d.	15	15	6 3 9	72/3	47/9	85/7½	57/3
1,590,000	1	Birfield Industries	53/– —1/–	15	20N	5 13 3	70/–	48/9	110/7½	48/9
3,196,667	1	Birmid Industries	56/9 —6d.	17½	17½	6 3 3	80/6	55/9	81/9	58/9
5,630,344	Stk. (£1)	Birmingham Small Arms	26/6 —3d.	10	8	7 11 0	33/–	21/9	39/9	20/–
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/–	5	5	6 13 3	16/–	15/–	18/6	14/10½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6% ...	16/6	6	6	7 5 6	19/–	16/6	21/6	17/9
500,000	1	Bolton (Thos.) & Sons	28/9	12½	12½	8 14 0	30/3	28/9	31/–	29/6
300,000	1	Ditto Pref. 5%	15/3	5	5	6 11 3	16/9	14/3	18/1½	15/9
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/–	7	7	7 7 3	22/3	18/9	23/–	21/6
9,000,000	Stk. (£1)	British Aluminium Co.	41/9 +9d.	12	12	5 15 0	72/–	38/3	81/10½	40/6
1,500,000	Stk. (£1)	Ditto Pref. 6%	18/6 +3d.	6	6	6 9 9	21/6	18/–	21/10½	19/6
15,000,000	Stk. (£1)	British Insulated Callender's Cables	40/–	12½	12½	6 5 0	55/–	40/–	54/9	45/3
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	31/6 —6d.	10	15N	6 7 0	39/–	29/6	63/6	32/3
600,000	Stk. (5/–)	Canning (W.) & Co.	20/3 —3d.	25	25	6 3 6	24/6	19/3	25/6	19/–
60,484	1/–	Carr (Chas.)	2/3	25	25	11 2 3	3/6	2/1½	3/–	2/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/7½ +1½d.	25	25	10 16 9	4/6	4/–	5/–	3/10½
555,000	1	Clifford (Chas.) Ltd.	15/9	10	15N	12 14 0	20/6	15/9	35/–	21/1½
45,000	1	Ditto Cum. Pref. 6%	15/10½xd +1½d.	6	6	7 11 3	17/6	16/–	19/–	17/9
250,000	2/–	Coley Metals	4/6 +4½d.	25	25	11 2 3	5/7½	3/9	5/1½	3/7½
8,730,596	1	Cons. Zinc Corp.†	49/6 +6d.	22½	22½	9 1 9	92/6	49/–	70/7½	46/3
1,136,233	1	Davy & United	46/3 —9d.	15	12½	6 9 9	60/6	42/6	50/6	41/3
2,750,000	5/–	Delta Metal	20/10½ —1½d.	*17½	*17½	4 3 9	28/6	19/–	25/9	18/3
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	25/3 —9d.	15B	22½	9 18 0	38/6	25/–	39/7½	30/–
500,000	1	Evered & Co.	42/–	15	15	7 2 9	52/9	42/–	56/–	52/–
18,000,000	Stk. (£1)	General Electric Co.	38/–	14	12½	7 7 3	59/–	38/–	65/6	41/3
1,250,000	Stk. (10/–)	General Refractories Ltd.	28/– +3d.	17½	17½	6 5 0	37/–	26/9	33/6	24/1½
401,240	1	Gibbons (Dudley) Ltd.	64/6 —6d.	15	12	4 13 0	71/–	53/–	54/–	50/–
750,000	5/–	Glacier Metal Co. Ltd.	5/10½ —1½d.	11½	11½	9 15 9	8/1½	5/10½	8/6	6/3
1,750,000	5/–	Glynwed Tubes	13/– +1½d.	20	20	7 13 9	18/–	12/6	18/3	15/9
3,614,032	10/–	Goodlass Wall & Lead Industries ...	29/6	18	16	6 2 0	37/3	28/9	34/7½	26/10½
342,195	1	Greenwood & Batley	46/10½	17½	17½	7 9 3	50/–	46/–	48/–	45/–
396,000	5/–	Harrison (B'ham) Ord.	12/3 —1½d.	*15	*30‡	6 2 6	16/9	12/4½	42/9	14/10½
150,000	1	Ditto Cum. Pref. 7%	18/9	7	7	7 9 3	22/3	18/7½	25/–	22/–
1,075,167	5/–	Heenan Group	7/3	10	20‡	6 18 0	10/4½	6/9	‖8/6	6/6½
142,045,750	Stk. (£1)	Imperial Chemical Industries ...	39/– +1/–	10	10	5 2 6	46/6	36/3	50/–	36/6
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/9 +7½d.	5	5	5 19 6	18/6	15/6	19/9	16/3
14,584,025	**	International Nickel	140 +4	$3.75	$3.75	4 18 9	222	130	210	141½
430,000	5/–	Jenks (E. P.) Ltd.	15/–xd +9d.	27½	27½	9 3 3	18/10½	15/1½	18/3	15/–
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/–	5	5	6 13 3	17/–	14/6	18/–	16/3
3,987,435	1	Ditto Ord.	40/– —7½d.	10	9	5 0 0	58/9	40/–	52/–	40/9
600,000	10/–	Keith, Blackman	16/3	15	15	9 4 6	21/9	15/–	25/10½	18/9
160,000	4/–	London Aluminium	3/10½xd	10	5	10 6 6	6/9	3/6	8/–	5/–
2,400,000	1	London Elec. Wire & Smith's Ord....	41/–	12½	12½	6 2 0	54/6	41/–	52/9	42/6
400,000	1	Ditto Pref.	21/3xd —4½d.	7½	7½	7 1 3	25/3	21/9	26/–	24/–
765,012	1	McKechnie Brothers Ord.	37/6	15	15	8 0 0	48/9	37/6	58/1½	50/6
1,530,024	1	Ditto A Ord.	36/3 —6d.	15	15	8 5 6	47/6	36/–	58/–	46/9
1,108,268	5/–	Manganese Bronze & Brass	9/1½ —3d.	27½‡	25	7 10 9	21/10½	7/6	18/9	15/4½
50,628	6/–	Ditto (7½% N.C. Pref.)	5/9	7½	7½	7 16 6	6/6	5/–	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	43/3	20‡	15M	4 12 6	59/–	40/3	54/6	41/6
415,760	Stk. (2/–)	Metal Traders	6/6 +1½d.	50	50	15 7 9	8/–	6/3	8/–	5/10½
160,000	1	Mint (The) Birmingham	22/6	10	10	8 17 9	25/–	21/6	25/3	22/6
80,000	5	Ditto Pref. 6%	83/6	6	6	7 3 9	90/6	83/6	92/6	84/6
3,064,930	Stk. (£1)	Morgan Crucible A	36/3 —3d.	10	11	5 10 3	54/–	35/–	48/3	38/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/3	5½	5½	6 7 6	19/3	16/–	20/7½	18/–
2,200,000	Stk. (£1)	Murex	57/3xd —4½d.	20	20	6 19 9	79/9	57/–	74/–	60/–
468,000	5/–	Ratcliffs (Great Bridge)	7/1½	10	10Y	7 0 3	8/–	6/10½	10/3	7/–
234,960	10/–	Sanderson Bros. & Newbould ...	24/9	27½D	27½	7 8 3	41/–	24/9	38/–	33/–
1,365,000	Stk. (5/–)	Serck Radiators	11/4½ —1½d.	17½Z	15	5 2 6	18/10½	11/6	16/3	12/3
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	43/9	16	16	7 6 6	57/6	43/9	59/6	49/–
600,000	1	Ditto Cum. Pref. 6½%	20/–	6½	6½	6 10 0	21/9	18/9	21/9	20/3
14,494,862	Stk. (£1)	Tube Investments Ord.	53/– +6d	15	15	5 13 3	70/9	50/6	70/7½	50/9
41,000,000	Stk. (£1)	Vickers	30/3 +3d.	10	10	6 12 3	46/–	29/–	44/6	32/4½
750,000	Stk. (£1)	Ditto Pref. 5%	15/6	5	5	6 9 0	18/–	14/–	18/7½	15/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/6	*5	*5	7 3 6A	24/9	20/7½	25/6	22/6
2,200,000	1	Ward (Thos. W.), Ord.	71/9 +9d.	20	15	5 12 9	83/–	64/–	69/3	58/9
2,666,034	Stk. (£1)	Westinghouse Brake	34/3 +1/9	18P	18	5 5 0	85/–	29/1½	100/6	68/–
225,000	2/–	Wolverhampton Die-Casting ...	7/7½	25	40	6 11 3	10/1½	7/–	14/10½	8/–
591,000	5/–	Wolverhampton Metal	16/–xd +1/3	27½	27½	8 12 0	22/3	14/9	21/10½	16/–
78,465	2/6	Wright, Bindley & Gell	3/7½ —1½d.	20	17½E	13 15 9	3/9	2/7½	3/9	2/6
124,140	1	Ditto Cum. Pref. 6%	11/6	6	6	10 8 9	12/6	11/3	14/–	12/4½
150,000	1/–	Zinc Alloy Rust Proof	2/7½ —1½d.	40D	33½	10 3 3	5/–	2/9	4/–	3/9

*Dividend paid free of Income Tax. † Incorporating Zinc Corpn. & Imperial Smelting. ** Shares of no Par Value. ‡ and 100% Capitalized issue. • The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. H and 200% capitalized issue. M and 10% capitalized issue. Y and 25% capitalized issue. ‖ Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share or £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B Equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue.